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Since the design of the engine research was aimed at the need for basic Stirling cycle research, consideration was given to the ability to measure key thermodynamic characteristics. Many instrumentation ports were incorporated in the hardware during the fabrication of the engine. Also considered at the time of fabrication was the requirement for reliable operation, short teardown and rebuild times, and flexibility of configurations. Because the research to be carried out was not intended to be on the heat input system, an electric resistance heater was developed. This heater will be discussed in detail in a later section. For similar reasons, a dashpot load was installed to absorb the power generated by the engine. This load will also be discussed in a later section. Figure 1 is a cutaway view of the RE-1000 showing the internal parts with some of the key components labeled. Figure 2 shows the engine installed in the NASA Lewis test facility.

The purpose of the tests performed with the RE-1000 was to collect data throughout a test matrix and to use these data to validate computer simulations of the Stirling cycle. The test matrix developed was intended to exercise the engine over a wide range of operating conditions to find the parameters to which the engine has a great amount of sensitivity, and also to find parameters to which the engine has little sensitivity. The matrix not only varied the operating conditions of the engine, but also varied the configuration of the engine hardware. Changes in the operating condition were accomplished by varying the working fluid, the mean pressure level, the heater and cooler temperatures, and the power piston stroke. Changes in the configuration of the engine were accomplished by varying the power piston mass, the regenerator porosity, and the displacer dynamics.

At the end of the sensitivity testing, a total of 781 data points were accumulated. During some of the testing, a measurement of the dynamic pressure drops of the heat exchangers was recorded. The measurement of steady-state pressure drops for each of the engine configurations was also recorded. A discussion of the measurement of the dynamic pressure drops of the heat exchangers will be presented in a later section.

This report presents a complete description of the RE-1000 engine suitable for computer modeling of the test hardware. A description of the test methods and the instrumentation is given. The 781 data points recorded during the sensitivity tests are presented in detail along with suggestions on how some of the data should be used. Some of the data are given in the form of graphs to show the general trends of the engine performance. A sample of the detailed data readings is presented in tabular form but the entire collection of data on a microfiche card can be requested from NASA Lewis.

DESCRIPTION OF THE SENSITIVITY

Test Program

During the initial stages of the NASA Lewis free-piston Stirling test program, a need was recognized for data recorded over a wide range of operating conditions for the purpose of computer code validation. Little free-piston Stirling engine data had been published and none of it was in enough detail to be used for code validation. With the ability to change the configuration of the RE-1000 engine and the wide range of operating conditions at which the

RE-1000 FREE-PISTON STIRLING ENGINE

SENSITIVITY TEST RESULTS

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SUMMARY

The NASA Lewis Research Center has been testing a 1 kW (1.33 hp) free-piston Stirling engine at the NASA Lewis test facilities. The tests performed over the past several years have been on a single cylinder machine known as the RE-1000. The data recorded were to aid in the investigation of the dynamics and thermodynamics of the free-piston Stirling engine. The data are intended to be used primarily for computer code validation. NASA reports TM-82999, TM-83407, and TM-87126 give initial results of the engine tests.

The tests were designed to investigate the sensitivity of the engine performance to variations on the mean pressure of the working space, the working fluid used, heater and cooler temperatures, regenerator porosity, power piston mass and displacer dynamics. These tests have now been completed at NASA Lewis.

This report presents some of the detailed data collected in the sensitivity tests. In all, 781 data points were recorded. A complete description of the engine and test facility is given. Many of the data can be found in tabular form, while a microfiche containing all of the data points can be requested from NASA Lewis.

INTRODUCTION

A free-piston Stirling engine has been under test at NASA Lewis as part of the Stirling engine technology program. The engine was intended to be used for basic research of specific thermodynamic processes involved in the Stirling engine cycle. The engine, known as the model RE-1000 was designed and built by Sunpower Inc., of Athens, Ohio in 1979 for NASA Lewis. The name RE-1000 indicates that the device is a research engine producing approximately 1000 W of brake power.

The RE-1000 engine, as tested at NASA Lewis, does not represent an engine design optimized as a total system. The goal used during the initial stages of the design was to produce an engine with maximum efficiency at the design condition of 1 kW brake power output. The starting point of the design task, however, was to use an existing design of a cooler that was intended to be used on an engine with 3 kW brake power output. The size of the regenerator cavity was also taken from the existing 3 kW design. With these constraints, along with the heater tube temperature fixed at 600 °C, cooler temperature of 25 °C, mean working space pressure of 7.0 MPa, and Helium as the working fluid, the Sunpower optimization code was used to maximize the efficiency. The engine is described in references 1 and 2.

engine could be run, a test program was designed to exercise the engine over many configurations and operating conditions.

The sensitivity tests were developed to provide this much needed data with the use of the RE-1000. The term sensitivity was used to describe these tests because the engine would be exercised throughout a matrix of operating conditions with eight parameters being varied. The data could then be studied to better understand how the engine responds not only to changes in the operating conditions, but also to changes in the configuration of the hardware. Three of the varied parameters were configurational changes of the hardware. These changes include variations in the power piston mass, regenerator porosity, and the displacer dynamics. A description of each of these configurational changes is given later in this report. The other parameters varied include the power piston stroke, the mean operating pressure in the working space, the working fluid, the heater temperature and the cooler temperature.

With the data collected in these tests, it would be possible to see which parameters strongly influence the performance of the engine and which parameters have little if any effect on the engine performance. Because these tests cover a wide range of operating conditions it would be possible to see the trends of the engine on a macro basis rather than on a small, local basis. This feature is helpful in the validation of computer simulations since a computer code should be able to predict engine performance over a wide range of conditions. Descriptions of the NASA Lewis Stirling engine simulation and the calibration of it are given in references 3, 4, 5, and 6.

Figure 3 shows a segment of the sensitivity test matrix. The parameters varied in this matrix were mean engine pressure level, heater head temperature, and cooler temperature. Inside each of the elements of this matrix the stroke of the power piston was varied. The stroke was varied in increments of 0.2 cm from 1.8 cm up to an upper limit determined by the operating conditions of the engine. In some cases, the upper limit of the stroke was determined by the presence of system instability causing the engine to operate with a low frequency beat imposed on the engine operating frequency. Other times the stroke was limited by either the condition of no load being applied to the piston or by the increased risk to the engine instrumentation. In all cases, the stroke was kept below a limit of 3.6 cm because of physical limits in the engine.

The matrix depicted in figure 4 shows the variations in the configuration of the test hardware. The configuration matrix shows that the engine was tested with all four possible combinations of the two regenerators and two displacers. In addition to these four configurations, the tests were run with the regenerator 1 and displacer 1, but the working fluid was changed to nitrogen for one series of tests and to argon for another series. A series was also run with a power piston with a mass less than the design mass. It should be noted that the matrix shown in figure 3 exists once inside of each of the elements of the matrix shown in figure 4. Table I gives a listing of the number of data points recorded for each of the elements of the configuration matrix.

The test matrix was designed to provide a method to detect the potential weakness of a Stirling engine computer simulation. When a computer simulation is calibrated against too few data points, the code may be very accurate when simulating a point near the conditions it was calibrated against, but may have significant errors when it tries to predict engine performance at an operating

point far from the calibration conditions. This may be caused by the adjustment of calibration factors that tend to counteract one another in some respect. The idea that it is desirable to calibrate a computer code over a wide range of data conditions led to the detail design of the sensitivity test program.

The data can be used to study the sensitivity of the RE-1000 to variations in any one parameter with all other parameters held constant. While this is done in most engine test programs to some degree, (i.e., the engine speed is usually varied as the pressure level is held constant in most kinematic Stirling engines as shown in ref. 7), it is possible to use data from the current sensitivity tests to look at the variation in engine performance with respect to any of the controlled parameters used as a test variable. With this in mind, the significance of some of the tests becomes more clear. If data points are used for code validation where the test parameter varied is the working fluid while all other parameters are held constant, some of the deficiencies of a code that are a function of the gas properties can be found. By using the data points recorded when the mass of the power piston was the test variable, the deficiencies of a code that are frequency dependent can be found. This can be very helpful in the calibration of a Stirling simulation since the configuration of the engine and the gas properties are held constant and the operating frequency of the engine is changed.

DESCRIPTION OF THE ENGINE

Along with the cutaway drawing of the RE-1000 free-piston Stirling engine shown in figure 1, a photograph of the engine in the test cell is shown in figure 2. The engine is relatively large and massive for its power level for several reasons. The engine as built for NASA Lewis, was intended to be a rugged test engine to be used for many hours of research. Since there was no interest in demonstrating the feasibility of commercialization or production features of the engine, no consideration was given to make the engine light or compact. A design requirement was to make the engine reliable and provide ease of maintenance. Consideration was also given to the ability to get instrumentation into key locations to enable the measurement of some thermodynamic characteristics. Generally, ports were incorporated at the connecting ducts between the heat exchangers for gas property measurements.

As can be seen in figure 1, the RE-1000 is a single cylinder free-piston Stirling engine with a posted displacer, annular regenerator and cooler, electric resistance heater head, and a dashpot load device built inside of the bounce space. The significance of the posted displacer configuration is that the displacer dynamics are coupled to the engine housing by the displacer gas spring. (The other possible configuration is to couple the displacer dynamics to a gas spring inside of the power piston.) Since the engine housing of the RE-1000 is very massive relative to any other engine component, the driving force that the displacer responds to during operation is the pressure variation of the working space. The response of the displacer generally follows the classical linear vibration theory as described in reference 8. Some nonlinearity does exist in the engine however and the linear theory does not yield a perfect representation of the dynamics.

The sliding surfaces of the engine use wear couples. The power piston is coated with a fluorocarbon material and the cylinder is coated with chrome

oxide. The displacer rods are coated with chrome oxide while the bores of the displacers are hardened stainless steel. Advances in Stirling engine technology include the use of hydrostatic and hydrodynamic gas bearings as described in references 9 and 10.

A complete list of engine parameters and dimensions is given in table II. It is intended that this list should be a complete description of the RE-1000 for its modeling on a computer. In the event of any conflict, the data presented in this table supersedes any previously published data with respect to the dimensions and configuration of the NASA Lewis RE-1000 since some alterations and more accurate measurements have occurred.

Heater. - The RE-1000 heater head is shown in figure 5. The heater was made with 34 tubes of Inconel 718. The tubes are used to form an electric resistance heater. As can be seen in figure 5, 17 of the tubes are connected at their midpoints to a semicircular electric bus bar. The other 17 tubes are connected at their midpoints to another electric bus bar. Each of the electric bus bars has two power tabs extending radially from the center of the heater. The flow of current from the one bus bar, through 17 of the tubes to the cylinder produces heat in those 17 tubes. The cylinder of the engine is at electric ground. Heat is likewise generated in the other 17 tubes as the current flows away from the head, through the tubes to the other bus bar and its power tabs, back to the electric power supply. The heat is generated by the high current, low voltage system.

The four power tabs that extend radially from the two bus bars were sized to generate heat in an attempt to minimize the heat loss from the heater tubes. With the proper amount of heat generated in each power tab, the temperature gradient in each tab would be zero at a point where the power tabs connect to the semicircular bus bars. A cross section of one power tab and its connection to the bus bar is shown in the exploded section of figure 5. The diagram shown in the exploded view illustrates how the power tab becomes neither a heat sink nor a heat source to the heater tubes. In this case, the heat conducted from the bus bars to the power tabs would be zero and the power tabs. The heat calculated in the data system as PWRIN, however, includes some of the heat generated in the power tabs that is lost to the surrounding air. This has an effect on any attempt to develop an energy balance or to calculate the engine efficiency based on the power input.

Each heater tube connects the expansion space to the hot end of the regenerator. The 34 tubes flow gas in parallel from the expansion space to a small plenum chamber at the hot end of the regenerator. As the tubes pass through the two semicircular bus bars, there is no mixing of the hot gas from one tube to another. The bus bars are brazed to the heater tubes only as a conductor for the electric current.

The heater head was fabricated with two semicircular bus bars attached to the midpoint of each of the 34 heater tubes. Since all of the heater tubes were fabricated from the same supply of tubing and therefore should be identical, every tube should be at the same temperature level during operation. The data always indicated that there was a tube to tube variation in temperature of as much as 20 °C. The variation was interpreted as misalignment of the thermocouples on the heater tubes and not a true variation of the heater tube temperatures. Since there is a voltage gradient along the length of the tube during operation, any misalignment of the thermocouple on the heater tube would cause

the thermocouple output to be the summation of the temperature induced output and the voltage gradient over the length of the thermocouple. This thought was substantiated by the fact that with each new installation of thermocouples, the highest heater tube temperature measured was on a different tube than on the previous tests.

Regenerator. - The regenerator cavity is an annular volume between the outside surface of the displacer cylinder wall and the inside surface of the gas-pressure containing wall. The regenerator matrix is a knitted 304 stainless steel material produced by Metex Corporation of Edison, New Jersey. Regenerator material is inserted into the regenerator cavity from the cold end of the heater head and becomes compressed when the cooler is attached to the heater head. The matrix structure is much like a metallic rope with a square cross section. The regenerator matrix is shown in figure 6.

The engine was tested with two different regenerators. The regenerators were similar with the exception that they had different porosities. When the engine was purchased at the beginning of the program it was built with a regenerator and a displacer that shall be referred to as regenerator 1 and displacer 1. These parts were produced as a result of the design goal of high engine efficiency within the original design constraints. At a later time in the testing of the RE-1000, NASA Lewis purchased a regenerator and displacer from Sunpower that were optimized for high power output with all other parameters of the engine held constant. These high power parts shall be referred to as regenerator 2 and displacer 2. Regenerator 1 had a porosity of 75.9 percent while regenerator 2 had a porosity of 81.2 percent. As a standard test procedure, the heat exchangers were flow tested after each rebuild. The results of the steady-state flow tests are given in figures 7 and 8.

Cooler. - The cooler of the RE-1000 is shown in figures 9 and 10. The cooler is of an annular design. The gas flow path consists of 135 rectangular passages spaced evenly around the displacer cylinder. The cooling water flows through passages in the cooler housing, parallel to the gas passages. The water flow direction during the tests was from the regenerator end of the cooler to the compression space end of the cooler. All of the parts of the cooler assembly are made of aluminum for low thermal resistance. The stainless steel displacer cylinder required a light press fit into the aluminum finned unit.

Displacer. - Tests on the RE-1000 were run with two different displacers. As discussed earlier, displacer 1 was designed for high efficiency and displacer 2 was designed for high power. The two displacers are shown in figures 11 and 12. Both of the displacers are similar in construction. The gas spring of the displacer is contained inside of the displacer body. The cold end of the displacer provides mounts for the antirotation rod and the displacer position measurement rod. The displacer position measurement rod extends into a linear voltage differential transformer (LVDT) built inside the power piston. This measures the position of the displacer relative to the power piston position since no easy method exists in the RE-1000 to measure the absolute displacer position. The antirotation rod prevents the LVDT core mounted on the displacer from becoming rotationally misaligned with respect to the LVDT windings built into the power piston.

The displacer rods are coated with chrome oxide for wear resistance. The rod is supported by the mounting spider located at the end of the rod. A small

bushing of Rulon is built into one of the legs of the spider to guide the displacer antirotation rod. The bore of the displacer, into which the displacer rod fits, is made of hardened stainless steel. On the end of the sleeve, inside of the displacer, an enclosed volume is attached to form the displacer gas spring. The volume was sized in each displacer gas spring to achieve a predetermined spring rate. Leakage of gas between the displacer gas spring and the working space is minimized by the close fit of the displacer rod in the displacer bore.

There must also be a seal to minimize leakage of the gas of the expansion and compression spaces from leaking between one another without flowing through the heat exchangers. This seal is a single ring of Teflon impregnated with molybdenum-disulfide. There was no backup ring used to provide a preload. The ring had a cross section of 3.00 mm (0.118 in.) by 2.82 mm (0.111 in.). Since little differential pressure across the displacer exists during engine operation a high drag piston ring similar to the ones used in kinematic engines is not necessary.

The two displacers and displacer rods differ in design. Displacer 1 was intended to operate with a phase angle of about 45° with respect to the power piston. Displacer 2 was designed to operate with a phase angle of approximately 80°. Displacer rod 1 was 1.663 cm (0.6548 in.) in diameter while the bore of the displacer was 1.666 cm (0.6558 in.). Displacer rod 2 was 1.808 cm (0.7120 in.) in diameter while the bore of the displacer was 1.811 cm (0.7130 in.). The combination of the gas spring stiffness, the displacer mass, and the damping to which the displacer was subject determined the dynamic response of the displacer to the pressure wave in the working space. Critical dimensions of the two displacers are given in figures 13 and 14.

One major difference between the two displacer rods was the instrumentation port provided in displacer rod 2 that could not be fit into displacer rod 1. This instrumentation port allowed the measurement of the pressure variation in the displacer gas spring as the engine was operating. Figure 12 shows the displacer rod with the instrumentation port labeled. The passage in the displacer rod caused a slight phase shift of the pressure reading but a negligible amount of attenuation. Because of this, the data reported contains a measurement of pressure amplitude but does not try to integrate the pressure-volume diagram of the gas spring. The error in the calculated loss would be too large relative to the actual value of the loss.

Power Piston. - The power piston of the RE-1000 is shown in figure 15. The main body of the piston is made of aluminum with the outer surface having a coating of a fluorocarbon anti-friction material. The larger diameter section of the piston was made of steel to increase the piston mass to the level required to make the engine resonant frequency become 30 Hz. For the tests conducted at the higher operating frequency this steel mass was replaced by a mass of the same dimensions but made of aluminum. This had the effect of making the oscillating mass of the piston lighter and therefore raised the resonant frequency to approximately 37 Hz.

A slot was machined in the side of the large mass to hold a Rulon bushing. This bushing would ride on a stationary rod during operation of the engine to prevent the piston from rotating. The bushing was made of Rulon to minimize friction. Misalignment of the power piston could cause damage to the instrumentation in the engine or the power piston itself. A new technology being

applied to free-piston Stirling engines involves the use of induced rotation to cause the displacer and the power piston to ride on hydrodynamic gas bearings. Some of the work on these bearings can be found in reference 9.

Three protrusions are on the end of the power piston toward the compression space. These three protrusions extend through the three openings of the displacer rod spider when the piston is at the inward end of its stroke. This feature was incorporated with the intent of reducing the dead volume of the engine.

The power piston uses a clearance seal to reduce gas leakage. The cylinder in which the piston rides is coated with chrome oxide. The inside diameter of the power piston cylinder is 5.722 mm (2.2528 in.), and the outside diameter of the piston is 5.718 mm (2.2514 in.).

The power piston of the RE-1000 with its original steel mass weighed 5.47 kg (12.06 lb). Other hardware attached to the power piston weighed 504 g (1.11 lb). This caused the total oscillating mass to be 5.97 kg (13.2 lb). Since this mass is nearly 15 times as large as the mass of a displacer, the dynamics of the engine are dictated by the inertia of the power piston. The operating frequency of the engine was approximately equal to the natural frequency of the piston mass rebounding against the gas spring formed by the working space. The bounce space in the large pressure vessel had a negligible effect on the frequency since its volume is about 100 times as large as the working space volume.

Centering ports. - Since a free-piston Stirling engine has no kinematic linkage to constrain the motions of the power piston or the displacer, a system is required to insure that the midpoint of the stroke of each oscillating part stays at some fixed location in the engine. This is necessary to insure that the piston and displacer do not collide with one another or with some physical limitation inside of the engine. This system is needed even if the hardware were able to be produced with perfect dimensions because the leakage past most of the seals in the engine is not symmetrical. A power piston will generally tend to drift into the working space, and in the configuration of the RE-1000, the displacer will drift toward the compression space.

Leakage in the engine is not symmetrical due to the variation of the density of the working fluid. As an example, the leakage of gas between the working space and the bounce space will be discussed. Since the bounce space undergoes no heating or cooling and the change in volume is very small compared to the total volume of the bounce space, the pressure in this space will be assumed to be constant. The pressure in the working space however undergoes a sizeable pressure variation. The equations describing the leakage between the two spaces indicate that the volumetric flow of gas will be equal in both directions. This flow rate is proportional to the square of the differential pressure across the leak path. The density of the gas flowing from the working space to the bounce space will be higher than the flow from the bounce space to the working space. There will be a net mass flow rate from the working space to the bounce space when the two volumetric flow rates are equal.

When the piston is at midstroke, a small port on the surface of the piston is aligned with a small port in the cylinder wall. The alignment of these ports allows the working space to communicate with the bounce space. This has the effect of forcing the engine to have no difference between the mean working

space pressure and the mean bounce space pressure when the engine is operating. This centering port system has been very effective and trouble free throughout the testing.

A similar system exists for the centering of the displacer stroke. In the case of the displacer, ports are aligned at midstroke that lets the small internal gas spring communicate with the large bounce space of the engine. This forces the pressure of the displacer gas spring to have its pressure equal to the mean pressure of the engine when it is at the center of its stroke. Figure 16 shows a cross section of the displacer centering port system.

When the engine is running, the centers of the piston and displacer strokes will not be at the exact same positions as when their respective centering ports are aligned. The distance between the center of the stroke and the centering port position will vary from one data point to another depending on the operating conditions. If the centering port system was made strong enough to force the center of the stroke to be at the same position as the centering port, a large loss may be incurred. This loss will be discussed later. The power piston of the RE-1000 has a maximum stroke of 4.35 cm (1.713 in.). The centering port for the power piston is aligned when the piston is 2.05 cm (0.807 in.) from the bumpers that limit its movement into the working space. Even though the piston does not touch the bumper during operation, the positions of the centering ports and of the center of the piston stroke were measured relative to these bumpers.

Displacer number 1 has a maximum stroke of 4.04 cm (1.591 in.). Its movement is limited by the end of the cylinder at the expansion space end of its stroke and by the spider that supports the displacer rod at the compression space end of its stroke. The centering port for displacer number 1 becomes aligned when the displacer is 1.90 cm (0.75 in.) from the expansion space limit of its movement. The dimensions for displacer number 2 are 5.18 cm (2.039 in.) for the maximum stroke and 2.64 cm (1.04 in.) from the end of its possible movement to the centering port position. Table III lists the volumes in the engine with both the power piston and the displacer at their respective center port positions. Locations of the different volumes are shown in figure 17.

Each of these centering port systems has some loss associated with it. This loss occurs in the form of gas flowing from the higher pressure side of the port to the low pressure side of the port each time the port opens. For the displacer centering port system this loss should not be too great. The reason for this is that the pressure in the gas spring of the displacer should be the same at both times the port opens during a cycle if there is no leakage and the spring has little hysteresis. The centering port of the displacer should only flow enough gas to correct for some slight leakage and a slight hysteresis in the spring. The power piston centering port, on the other hand, may have a great amount of loss associated with it. The reason for the loss is that the pressure in the working space at the two times during an engine cycle that the ports open is not nearly equal. One opening occurs when the power piston is in the process of compressing the working fluid and the other opening occurs when the power piston is expanding the working fluid. During the compression stroke most of the working fluid is in the relatively cool compression space while during the expansion stroke most of the working fluid is in the relatively hot expansion space. At one opening of the centering ports the working space pressure will be much greater than the bounce space

pressure, while at the other opening of the centering ports the pressure in the working space will be much less than the pressure in the bounce space. The result is that there is gas flowing from the working space to the bounce space at one opening of the ports and gas flowing in the opposite direction at the other opening of the ports. These two situations are diagramed in figure 18. For these reasons it is important to have the centering port systems of an engine no bigger than is needed to maintain proper operation.

In the RE-1000 tests were done to determine the best strength of the centering port system for the power piston. The piston originally had four centering ports. Each port was a 1.14 mm (0.045 in.) hole. Data was recorded with from one to four of the ports operational. When only one port was working, the power piston tended to operate far in toward the working space and would almost not open the centering ports at all. As the number of ports was increased, the piston ran more centered around the centering ports but the losses increased. The best combination found was with two of the four original centering ports in operation.

Leak paths. - There are several leak paths in the RE-1000 that should be included in any model to insure proper simulation. Leak paths that allow the gas in the working space to leak to and from the bounce space will be discussed. Not only are these leak paths not obvious at first look at the engine, but the number of paths that are leaking actually changes during the engine cycle.

Figure 19 shows the leak paths that involve the power piston and its cylinder. In the position that the piston is shown in figure 19(a) there are three different leak paths for the gas to use. The shortest path and therefore the path that probably allows the most leakage, is the path that connects the port in the piston to the port in the cylinder wall. This path is designated as path 1 in figure 19(a). The length of this path changes as the piston moves during operation of the engine. Path 2 connects the working space to the centering port in the cylinder wall. This port in the cylinder wall is always at the bounce space pressure level. The length of this leak path also changes during the engine cycle as the piston moves. Leak path 3 connects the centering port of the piston to the bounce space without going through the centering port in the cylinder wall. Care must be taken to realize that while the piston is on the outer half of its stroke as is shown in figure 19(a), there are three separate leak paths, but when the piston is on the inner half of its stroke there is only one leak path. Leak paths 2 and 3 do not leak because the centering port of the piston is on the working space side of the centering port of the cylinder wall. There will be no leakage between the working space and the piston centering port because they are both at the working space pressure. Similarly there will be no leakage between the bounce space and the cylinder centering port because they are both at the same pressure. A two dimensional description of the leak paths past the power piston is given in figure 20. The paths are shown for both halves of the engine cycle.

A similar situation exists for the displacer centering port system. In this case, there is leakage that involves three different gas volumes. When the displacer is on the half of its stroke toward the compression space, there are three leak paths as shown in figure 16(a). Leak path 1 connects the centering port in the displacer bore to the centering port in the displacer rod. This allows gas to leak between the displacer gas spring and the main

bounce space. Leak path 2 connects the working space to the centering port in the displacer bore. This allows leakage of gas between the working space and the displacer gas spring. Leak path 3 connects the displacer gas spring to the ports in the displacer rod. This leak path allows leakage in a parallel path to leak path 1. As was the case with the power piston, the number of leak paths in existence changes during the engine cycle. Leak path 2 changes to leak between the compression space and the main engine bounce space when the displacer has moved to the expansion space as shown in figure 16(b). Both ends of leak path 3 connect the same volume when the displacer has moved to the expansion space and therefore has no leakage.

Dashpot load. - The RE-1000 was built with a small dashpot as a load for the engine. Since the purpose of the testing was not to do research on power output conversion devices, the dashpot load system was well suited. The dashpot load device can be seen in figures 1 and 21 near the top of the engine. The dashpot was made with a carbon piston inside of a cylinder that would pump gas in the bounce space back and forth through an orifice. The orifice size was adjusted during each test to change the level of the load. The adjustment was accomplished by rotating a valve stem that had a 3° taper. The valve stem was rotated by means of an electric motor that can be call out at the top of the engine in figure 21. This load, being a damping device, produced a force resisting the piston motion that was nearly proportional to the square of the piston velocity. A water jacket was formed around the dashpot cylinder to cool the load device.

DESCRIPTION OF THE FACILITY

The RE-1000 test facility was built to supply all of the support systems needed to carry out the research program. The facility had a high pressure, 15.5 MPa, (2250 psi) gas system to supply the working fluid to the engine, a water system to cool the engine, and a dc electric power supply system to heat the engine. Along with these systems, a high speed data system was built to help in the data gathering process. Each of these systems will be described in detail. A simple schematic of the facility systems and some of the instrumentation built into the systems is shown in figure 21.

The gas system was designed with the ability to charge the engine with helium, hydrogen, nitrogen, or argon. The supply pressure to the engine was set with a remote control pressure regulator. The flow of gas into or out of the engine was controlled by motorized needle valves in the supply and vent lines respectively. To start the engine, a pair of solenoid valves alternatively connected the high pressure supply line or the low pressure vent line directly to the working space. The gas pulses would start the displacer and power piston in motion. If the motion was great enough, the engine cycle would continue to operate.

The water cooling system consisted of two separate systems. An open loop system was used to cool the dashpot load device. This system had no temperature control. A closed loop water system was used to cool the engine compression space. This water system was filled with distilled water. A heat exchanger with a feedback system controlled the temperature of this water loop. Water temperature varied during the tests from 25 to 55 °C. Temperatures and flow rates were measured in both systems to allow the calculation of heat rejection rates of the engine.

The engine heater power supply system consisted of two Sorensen electric power supplies connected in parallel. Each power supply unit had the capability of delivering 1000 A of direct current to the engine. The two power supplies were regulated by an automatic controller which used a thermocouple on one of the engine heater tubes as feedback. The heater temperature was varied from 450 to 600 °C during the engine tests. The control room for these systems is shown in figure 22.

DESCRIPTION OF THE INSTRUMENTATION

Since the purpose of these tests was to collect detailed data on the dynamics and thermodynamics of the free-piston Stirling engine, a variety of diagnostic instrumentation was installed. In all cases, the instrumentation was designed to have as little impact on the operation of the engine as possible.

All of the temperatures were measured with type K (Chromel-Alumel) thermocouples. Twelve heater tube temperatures were recorded for data use; their average was used to set the desired test conditions. Six of the heater tube temperatures were measured at the quarter-length point at the expansion space end of the heater tube, while the other six temperatures were measured at the quarter-length point of the heater tube near the regenerator end of the tube. The thermocouples attached to the heater tubes were closed ball and unsheathed. Thermocouples were added on the outer wall of the regenerator to aid in the calculation of conduction losses. The locations of the thermocouples installed on the heater head are shown in figure 23. These regenerator wall thermocouples were closed ball and sheathed.

Thermocouples used to measure the temperature rise of the water as it passed through the engine cooler or through the dashpot cooler were installed in a differential temperature configuration. This produced a signal proportional to the temperature rise of the water. The thermocouples were matched pairs to insure accuracy. These thermocouples were used in addition to the ones used to measure the water inlet temperature and the water outlet temperature because they give a more accurate reading of the differential temperature. Both the inlet and outlet temperatures were estimated to have a probable error of 1 °C compared to 0.2 °C for the temperature differential measurement.

A dynamic pressure measurement was made in the compression space. This measurement was used along with a measurement of power piston motion to calculate the indicated power of the engine. A dynamic pressure measurement was also made of the gas spring inside of displacer 2. As was mentioned earlier, the path that the gas pressure wave traveled caused a slight phase shift of the signal but a negligible amount of attenuation.

A great amount of work was done to develop techniques for accurate measurement of the dynamic pressure drop across each of the heat exchangers. Due to physical limitations in the installation of the instrumentation, measurements across the cooler, the regenerator, and across the entire heat exchanger circuit were made. Special attention was given to the response characteristics of the tubes that connected the transducers to the engine. Each tube was sized to provide the same acoustic response on both sides of the transducers. Corrections in the length of the lines were made to compensate for differences in the tube diameters and the gas temperatures. Tests

performed at NASA Lewis indicated that the transducers had insignificant sensitivity to mean pressure level but were affected by the temperature of operation. The transducer bodies were therefore water cooled so that the transducer would maintain a constant operating temperature.

The transducers installed to measure the dynamic pressure drops during engine operation were also used to measure steady-state pressure drops. Because these tests were run at steady-state conditions, the data is reported in the form of cooler pressure drop, regenerator pressure drop, and heater pressure drop. The heater pressure drop was calculated from the measurement of the total pressure drop minus the regenerator and cooler pressure drops. This same calculation was not done for the measurements of the dynamic pressure drops during operation of the engine. The reason is that while great care was taken to insure that the response was equal for both lines feeding any individual transducer, this does not guarantee that the response of the two lines feeding one transducer is the same as the response of the two lines feeding another transducer. Although any two transducers may in fact measure the pressure drop properly, there was no attempt made to synchronize one transducer with another. The reasons not to subtract one pressure drop measurement from another becomes even more apparent when it is realized that the actual pressure drops in the heat exchangers are not necessarily in phase with one another.

The displacer and power piston positions and the power piston velocity were measured. The power piston position and velocity were measured directly by a LVDT, and LVT (linear velocity transducer), respectively. The displacer position cannot be measured directly, since the displacer is completely enclosed in the working space. The displacer position was measured relative to the power piston position with the core of the LVDT attached to the displacer and the windings of the LVDT built inside of the power piston. The signal from the windings inside of the power piston was carried along wires from the moving piston that had to flex as the piston moved. These wires were supported by a piece of music wire 0.254 mm (0.010 in.) in diameter.

To obtain the absolute displacer position signal, the power piston position had to be subtracted from the displacer signal. An electric analog circuit performed the subtraction of the signals from the LVDTs. The circuit also measured the peak values of the signals to produce a measurement of the piston and displacer strokes.

A crystal-type force transducer was mounted in the link that connected the power piston to the dashpot load. Since the force transducer moves with the power piston, a wire system similar to the one used for the displacer signal had to be incorporated to relay the force transducer output signal to the data system. This dynamic measurement of the resistance force being applied to the power piston by the dashpot was used in an analog circuit along with the power piston velocity to calculate the brake power output of the engine. The equation used to calculate the power output was

$$\text{brake power} = \frac{FV \cos \theta}{2}$$

where

F amplitude of the force signal
V amplitude of the piston velocity signal
 θ phase angle between F and V signals

An error analysis method outlined in reference 11 was applied to this calculation of power. The resultant probable error was found to be 3 percent at the engine design conditions, assuming that all of the input signals maintained their individual accuracies. The indicated power output of the engine was calculated in a similar manner to that used for the brake power output. The dynamic compression space pressure was measured with a crystal type fast response pressure transducer. The equation used was

$$\text{indicated power} = \frac{PAV \cos \theta}{2}$$

where

P amplitude of the compression space pressure signal
A area of the power piston
V amplitude of the piston velocity signal
 θ phase angle between P and V

The same error analysis method was applied to this calculation and the resultant probable error was found to be 3 percent. Once again, this assumes that all of the input signals maintained their individual accuracies. Both the indicated power calculation and the brake power calculation were recorded by the data system.

Two phase angle meters were utilized in the data system. One of the meters measured the phase angle between the power piston and the displacer positions. The other phase angle meter measured the phase angle between the power piston position and the compression space pressure wave. The motions of the power piston and the displacer were not pure sine waves, and the pressure variation in the compression space also had some higher harmonic content. By strict definition, there can be no measurement of a phase angle between two signals that are not pure sine waves. By describing the measured motion of the power piston in a Fourier series it was found that approximately 97 percent of the piston motion is due to the 30 Hz fundamental frequency of the engine. The other 3 percent of the motion was contained in the higher harmonics. In the case of the displacer motion, 95 percent of the motion is in the fundamental frequency term and the remaining 5 percent is in the higher harmonics. The phase angles presented in these data represent the time interval between the positive going zero crossings of the two signals. The outputs from both of these meters were checked against other methods of measuring the phase angles and found to be accurate. The outputs from these meters were fed into the data system and appear on the data output.

A diagram showing the location of most of the instrumentation on the engine is presented in figure 24. A listing of all of the instrumentation used in the tests is given in table IV. The number located near each piece of instrumentation represented in figure 24 is an item number that can be used to identify the instrumentation listing in table IV.

Data was recorded by two different systems during the sensitivity tests. The NASA Lewis Escort system was used for the steady-state data and a separate

system was installed in the control room for recording the dynamic data. Most of the data signals were transmitted to the Escort data system. The Escort system is a microcomputer-based digital data recording and display system intended for steady-state use. The sampling rate of approximately 5000 samples per second permits the use of multiple scans, which are averaged for each data point recorded. The data system uses five scans of data recorded over a 15 sec period. Calculations are performed to indicate the statistical variation of each channel recorded over the total number of scans.

The Escort system has the ability to convert millivolt signals to engineering units with preprogrammed calibrations. The system can do any predefined calculations with the parameters and display the results on either a set of light emitting diodes (LED) or on a preprogrammed cathode ray tube (CRT) display. There were 15 LEDs available for these tests. The CRT could be programmed to have many different displays, or pages, that could be viewed during the test sessions. An important feature of the Escort system was its ability to do limit checking during the tests. The system could check for high or low limits of any of the data channels or calculated parameters, and then provide either a warning of limits violation or perform some predefined action, such as the initiation of a shutdown procedure. Both the LEDs and the two CRTs can be seen in the control room in figure 22. More information on the Escort system may be found in reference 12.

While the Escort system was able to handle the steady-state data channels, it did not fulfill the sample time requirements to record dynamic data channels. The dynamic data were handled by several different methods. Phase angles were measured with phase angle meters. The inputs to these meters were the dynamic engine parameters from the LVDTs and the compression space pressure transducer. The output from these meters was used as an input to the Escort data system. The measurements of the piston stroke, the displacer stroke, and the calculations of the indicated and brake power levels were performed by analog electronic circuits. The analog electronic circuits were checked for accuracy by comparing their measurements to measurements made by other methods and were found to be accurate. These analog circuits were recalibrated regularly to insure accuracy was maintained.

All of the dynamic signals were recorded for each data point on a Honeywell Visicorder. The parameters recorded on the Visicorder are indicated as such in table IV. Some data reduction was performed with the output from the recorder after each test run. The measurements resulting from this output include the amplitudes of the three differential pressure transducers, the amplitude of the compression space pressure wave, the center position of both the displacer and power piston strokes, and the amplitude of the pressure wave in the displacer gas spring for displacer 2. These parameters were later merged with the steady-state data and appear on the output of the steady-state data system.

Table V provides a list of the calculations performed in the data reduction process. The exact form of each calculation is presented in appendix B. This appendix also gives a calculated error for each of the calculations based on the probable error of the inputs for the calculation.

DESCRIPTION OF THE TEST PROCEDURE

The RE-1000 engine installed in the test facility is shown in figure 2. Before any test session was initiated a calibration of all pressure transducers was performed automatically by the Escort data system. The engine was purged of air by a pressure-vent cycle of the working and bounce spaces. The engine was then pressurized with the desired working fluid to some pressure level between 5.5 MPa (800 psig) and 7.0 MPa (1015 psig) depending on the test conditions to run on that particular day. Since the engine would usually start to run after fewer than five impulses from the starter system, regardless of pressure level, it was not important to be at any particular pressure level to start the engine. On most test runs the engine would become self sustaining after two impulses.

After the engine was purged of air and pressurized with the desired working fluid, the electric heat input was started and the cooling water flows were set to their proper levels. The dashpot load was set to give little or no resistance to the power piston motion. When the heater tube temperature reached 600 °C, the engine was given pressure pulses from the starter system until self sustaining operation was achieved. The dashpot needle valve orifice was then adjusted to give the proper load to the engine for the piston stroke desired.

After typically 2 min of operation, all measured temperatures had reached their steady-state values. (The shortness of the transient period is due to the very low thermal inertia, including the absence of an oil lubrication system that kinematic engines have.) Although steady-state temperature readings were obtained in about 2 min, the engine would typically be allowed to operate at the initial test conditions for 15 min or more.

When recording data, the points were recorded in order of increasing stroke. The engine would be held at the desired operating conditions, (i.e., temperature and pressure) with the power piston stroke at 1.8 cm. After this point was recorded, the dashpot setting was adjusted to allow the power piston stroke to reach 2.0 cm. The piston stroke was increased in increments of 0.2 cm and data was recorded until the stroke reached 3.6 cm or until the engine operation started to become erratic. The engine was allowed to operate at each new condition for 5 min before this new data point was recorded.

It must be noted that the test conditions were traversed in a rather orderly fashion. For example, the first series of data points recorded may have been with the conditions of 450 °C heater temperature, 25 °C cooler temperature and 5.5 MPa mean pressure level. The next three series taken would then be at the same conditions with the heater temperature set to 500, 550, and 600 °C respectively. Similar data points would then be recorded for these same operating points with the mean pressure level set at 7.0 MPa. This test procedure, although convenient, can result in misleading data. The reason is that if there were any changes in the instrumentation characteristics that were a function of time, these changes would mistakenly be interpreted as being a result of the changed engine operating conditions. If, on the other hand, the data points are traversed in a random fashion the changes in the instrumentation characteristics will show as scatter in the data. This is also true for changes in the engine as it accumulates run time if there are any parts that are susceptible to wear. This is discussed here to indicate that although it

was recognized that the data matrix should be traversed in a completely random fashion, it was felt that it was not possible within the time frame of the sensitivity tests.

SAMPLE TEST DATA POINT

Some sample data points will be discussed in this section to provide a better understanding of the format used to present the data output. Table VI contains all of the data points that have only one of the set conditions varied from the design conditions. Within this set, data points 1006 to 1012 will be examined. The mean pressure reading of the engine was set at 7000 kPa. This can be seen by the mnemonics MEANCP and MEANBP. These are the mean compression space and bounce space pressure readings respectively. The average value of the 12 heater tube temperatures was set at 600 °C which can be seen by the mnemonic TAVHTR. The cooling water inlet temperature was set at 25 °C as shown by TWINCL. The piston stroke was set at 1.8 cm on data point 1006 as indicated by the parameter PISTST and then increased by 0.2 cm on each successive data point. These parameters are specified by the sensitivity test matrix. All other values on the data sheet are a result of the engine operating at these set conditions.

In the column on the left side of the data sheet there are two sections. These sections are labeled "HEAT TO DASHPOT COOLING" and "HEAT TO COOLER". The calculation used in each of these measurements is based on the water mass flow rates and the differential temperature measurements of the respective cooling loops. The parameters TDLDP and TDLCI are the differential temperatures. Note that these measurements are not equal to the outlet temperature minus the inlet temperature in either case. This results from the locations of the thermocouples used for the inlet and outlet temperature measurements versus the locations of the thermocouples used for the differential temperature measurements. It also results from the improved accuracy of the differential temperature measurement versus the subtraction of two absolute temperature measurements. As previously stated, both the inlet and outlet temperatures were estimated to have a probable error of 1 °C while the differential temperature measure has an estimated probable error of 0.2 °C. Subtracting one temperature from another to calculate the differential temperature can lead to substantial errors when the differential temperature and the probable errors are of the same order of magnitude.

In the second column appear the measurements of the electric power input to the heater head and the calculations performed by the Escort data system. The parameter VOLTG is the voltage across the resistance of the heater head and was measured from a point on the electrically positive power tab near the semi-circular bus bar to a similar point on the electrically negative power tab. This measurement therefore was not the true voltage that existed across the heater tubes alone.

The calculated parameters Pressure Factor of the Piston (PFP), and Pressure Factor of the Displacer (PFD), are shown in graphic form in figure 25. The phasor diagram represents the operating condition at the design point. The format of the diagram follows the vector notation outlined in reference 13. The pressure wave of the engine is divided into two components, one in phase with the piston motion and one in phase with the displacer motion. In general, the component of the pressure wave in phase with the piston motion has been

caused by the piston motion. Similarly, the component of the pressure wave in phase with the displacer motion has been caused by the displacer motion. The vector PFP is the pressure variation in the working space that is the result of the piston motion, divided by the amplitude of the piston. The vector PFD is the pressure variation in the working space that is the result of the displacer motion, divided by the amplitude of the displacer. This provides an easy check on the effectiveness of the piston and displacer motions although care must be taken since it is not an exact measurement of the performance of the piston or displacer. By definition, the PFP vector is parallel to the power piston vector and the PFD vector is parallel to the displacer position vector.

A calculation of the Beale number is included in this column. The Beale number, as outlined in reference 13, gives an indication of how well the engine makes use of its swept volume and pressure level for the conversion of energy. All of the calculations are presented in appendix B.

The third column of the data sheet has several different types of measurements. The parameter PRESUP is the supply pressure to the engine. MEANBP and MEANCP are the average pressure levels of the bounce space and the working space respectively. Vibration transducers were mounted on the large base plate of the engine. The measurement represents the vibration level of the entire engine housing, measured in terms of peak velocity (cm/sec). This measurement, along with the frequency of the engine, can be used to calculate the motion of the engine housing.

The fourth column presents measurements of the mean temperatures of the gas inside the engine housing. Below these readings is a section labeled "REMOTE CALCULATIONS". The four parameters represent calculations executed by the analog circuits. All of the parameters listed under the title "DYNAMIC CALCULATIONS" were measured from the Visicorder traces. PAMPC is the amplitude of the pressure variation in the compression space. PISTCP and DISPCP give the center position of the power piston and the displacer: i.e., the distance from inward limit of the possible movement to the center of the oscillatory movement. As an example, for data point 1010 the center positions measured were 2.33 cm for the power piston and 2.37 cm for the displacer. It was stated in the "Centering Port" subsection of the section "Description of the Engine", that the centering port of the power piston opened when the power piston was 2.05 cm from the inward limit of its motion and the displacer 1 centering port opened when its position was 1.81 cm from its inward limit. This indicates that for data point 1010, the center of the center power piston stroke was $2.33 - 2.05 = 0.28$ cm from the center port location. Similarly, the displacer was operating $2.37 - 1.90 = 0.47$ cm from the center port location.

Measurements presented in this column also include the pressure amplitude inside the gas spring of displacer number 2, PDYNDB. The last three parameters listed give the amplitudes of the dynamic pressure drop measurements. PDLCLR and PDLREG are the pressure drop amplitudes across the cooler and the regenerator respectively. PDLDIS is the pressure drop across the total heat exchanger system as measured between the expansion and compression spaces.

The last column gives the individual heater tube temperature readings. From these individual readings, the average heater tube temperature was calculated and the heater temperature was set. There is some scatter in the readings of the tube temperatures. There are two effects causing this scatter.

First, there is some variation in the temperatures of the heater tubes due to the slight tube to tube variation in electrical resistance. Second, the voltage gradient along the length of the heater tube may effect the accuracy of the temperature measurement. The voltage gradient can be either added to or subtracted from the voltage signal of the thermocouple if the thermocouple is not either electrically insulated from the heater tube or known to be mounted perpendicular to the voltage gradient. Both of these effects probably contributed to the variation in the measurements, but since there were 12 thermocouples, the average of all the heater temperatures should still represent the operating temperature of the heater. Another indication that misalignment of thermocouples was responsible for some of the scatter in the heater temperatures was that a heater tube that indicated the highest temperature with one set of thermocouples was not always the same tube that indicated the highest temperature with the next set of thermocouples. Typically the thermocouples were replaced during each rebuild.

The temperatures in the lower part of the last column are the outer wall temperatures of the regenerator. The locations of these measurements are shown in figure 23. The equation used to determine the axial conduction losses of the regenerator wall from these measurements are listed in appendix B.

When any measurement is made, there is some amount of error associated with each reading. In the case of the RE-1000, being a free-piston Stirling engine (FPSE), the measurement errors are important and in some instances highly significant when calculations are performed. This must be considered when the data is being used to validate computer simulations of the engine cycle. If a code is being validated to produce good agreement in the prediction of indicated power with test data, the validation work can go no further when the code predicts a value of indicated power that is within the error band of the data. For a FPSE, the error band on the indicated power measurement is at times significant. The reason is that there are errors associated with: (1) the volume measurement, (2) the dynamic pressure measurement, and (3) matching the time scales of the two measurements. While it is possible to measure each of these parameters with acceptable accuracy, the size of the error of each signal relative to the size of the signal must be considered. When synchronizing time scales, any phase shift of the two signals relative to one another can lead to a sizeable error in the calculated value of indicated power since the phase angle between the pressure and volume signals is small. Any error in the synchronizing of signals will have a large effect when added to this relatively small phase angle.

With proper technique, measurement errors can be kept to a minimum. An example of minimizing measurement error can be seen in the calculation of heat rejected by the engine cooler. The thermocouples used measuring the temperature rise of the water as it passed through the engine cooler were connected in a differential temperature configuration. If the differential thermocouple configuration has a maximum error of 1.0 percent then the reading will indeed be very accurate. If on the other hand the differential temperatures were measured using two separate thermocouples, there will be an error associated with each of the two temperature measurements. The summation of these two errors will most likely be quite large when compared to the temperature rise intended to be measured.

Estimated probable errors associated with each of the parameters measured in this test program are listed in table IV. The error associated with each of

the calculations is presented in appendix B. In cases where the exact value of the probable error of an individual parameter was not known an estimate was made based on experience with that particular type of instrumentation.

DESCRIPTION OF THE TEST MATRIX

The test matrix was devised to generate the data necessary to characterize the sensitivity of the RE-1000 with respect to each of the parameters that define the test point, plus several configuration related parameters. The attempt was made to optimize the matrix to minimize the number of test conditions and data points. While the engine was designed to operate at temperature levels up to 650 °C, for the reasons of reliability the test matrix was limited to values of 600, 550, 500, and 450 °C. Since power and efficiency are also dependent on the cooler temperature, three levels were chosen: 25, 40, and 55 °C. The engine was designed to operate with helium as the working fluid at a mean pressure level of 7.0 MPa (1015 psig). The test matrix used pressures of 7.0 MPa (1015 psig), 5.5 MPa (798 psig), and 4.0 MPa (580 psig). Testing the engine at four heater temperatures, three cooler temperatures, and three pressure levels, would generate 36 different test conditions for each configuration. To maintain the size of the test matrix at a reasonable level, it was decided that the 14 conditions shown in dashed lines in figure 3 were eliminated. The conditions remaining in figure 3 were used for all four combinations of the two displacers and two regenerators. Figure 4 shows that only displacer 1 and regenerator 1 were used when running tests with either the light weight power piston or an alternate working fluid.

Figure 4 shows the number of data points recorded for each of the configurations. The seven versions of the test condition matrix shown in figure 26 give the data point reading numbers for each of the conditions. With this figure, the reading number for any desired condition can be found. The lower of the two numbers that appear in an element is the reading number of the data point recorded at the shortest power piston stroke tested. In all cases, this value was 1.8 cm. Each successive data reading had the power piston stroke increased by 0.2 cm. As an example, if an element has only four data readings listed in it, the engine was tested with power piston stroke settings of 1.8, 2.0, 2.2, and 2.4 cm.

All 781 data points are not needed to validate a computer code, so the test matrix was divided into two smaller subsets. These two matrixes are called the "Single Variable Data Set" (SVDS) and the "Double Variable Data Set" (DVDS). A list of the data points in the SVDS is given in table VII and a list of the data points in the DVDS is given in table VIII. The remainder of the data can be obtained on microfiche from NASA Lewis by request.

The RE-1000 was designed for high efficiency at the set conditions of 600 °C heater head temperature, 25 °C cooling water inlet temperature, 7.0 MPa mean working pressure with helium and a power piston stroke setting of 2.6 cm. The configuration used included the standard power piston, regenerator 1 and displacer 1. This test condition was recorded on data reading number 1010. Since there were eight test parameters varied during the sensitivity tests, there should be eight different curves that can be plotted showing the sensitivity of the engine to any one of the eight parameters, while the other seven parameters are kept at their respective design conditions. If these plots were generated, every one would contain data reading 1010. The collection of all of

the data points needed to produce these plots is called the SVDS. The title Single Variable Data Set indicates that only one of the eight variable parameters was allowed to deviate from the design condition. Table VII gives the data point reading numbers for all of these points, and also shows which data points are needed to generate each of the eight curves. Table VII shows that the SVDS contains only 18 data points and is therefore an easier data set to work with for computer code validation. This data set can be used to check the sensitivity of a computer code prediction against the sensitivity of the engine for any of the eight test parameters varied.

Figure 27 shows some plots generated from the SVDS. These plots indicate that performance of the RE-1000 obeys the general trends attributed to free-piston Stirling engines. As the power piston stroke is increased, the indicated power produced increased. The displacer stroke also grew as the power piston stroke increased. The displacer stroke growing can be attributed to the larger pressure wave in the working space when the piston is sweeping more volume. The larger pressure wave provides more driving force for the displacer to respond to during operation. It can also be seen in figure 27 that both the indicated power and the efficiency increase as the heater temperature increases.

In some cases the plots generated from the SVDS contain only two points. This is true for any plot of the engine performance with the power piston mass as the independent variable. The engine was tested with only two different levels of power piston mass. This is also true for the variations of the displacer dynamics, the regenerator porosity, and even with the working fluid. The reason this is true for the working fluid is that even though the engine was tested with three different working fluids, the design conditions for the other seven variables could not be reached when tests were being conducted with argon as the working fluid. In an attempt to expand the collection of data points in the SVDS, the DVDS was formed. The DVDS was generated from the SVDS by taking each data point in the SVDS and allowing the power piston stroke to be varied over its entire range. By doing this, a collection of 79 data points was formulated. The list of the data points in this collection is shown in table VIII with the lowest value number of each set being the reading number for the set point condition indicated and the power piston stroke set at 1.8 cm. Each successive reading number had the power piston stroke increased by 0.2 cm. Appendix C contains the data of the DVDS printed out in the same format as described earlier. Figure 28 shows some plots of engine performance using data from the DVDS. Unlike the SVDS, the DVDS can be used to generate plots that show families of curves. Once again it can be seen that the RE-1000 obeys the general laws of FPSE operation.

Some data not included in the SVDS or in the DVDS but that still may be of importance are presented in appendix D. These data points were recorded with both the high power displacer and the high power regenerator installed in the engine. A description of the data points can be found in appendix D.

USE OF THE TEST DATA

There are some important characteristics of the test data that must be understood when the data is being used to validate a computer simulation. These areas will be discussed to provide better insight into the interpretation

of the test data. In all cases the data will be shown to be completely valid, but it will also be shown that the data must be used in the proper manner.

As was described in the section on the sample data output, the motions of the displacer and the power piston were measured in terms of their strokes and their phase relationship to one another. The compression space pressure wave was also characterized by its amplitude and its phase angle relative to the power piston. This assumes that all three of these parameters can be characterized as sinusoidal in nature, without any higher harmonics. A study was performed to test the validity of this approach with the NASA Lewis Stirling engine simulation used in the constrained mode. More information on the details of the NASA Lewis simulation can be found in references 3, 4, 5, and 6. Some of the data points from the SVDS were chosen for this test, and the measured piston motion and displacer motion were digitized. These digitized wave forms were analyzed and their respective Fourier series were generated. Both the power piston and the displacer motion are dominated by the fundamental frequency with only a small part of the motion attributed to the harmonics. Higher harmonics of the fundamental frequency accounted for 1.4 percent of the piston motion and 3.5 percent of the displacer motion. The series solution for each of these wave forms, up to the third harmonic of the fundamental frequency were used as inputs to the NASA Lewis computer code. The results of these simulations were compared to the results of the simulations run with the inputs being in the same form as the data presented in this report. The difference in the code predictions with the two different forms of inputs was negligible. This comparison was made between the two different methods of inputting the data without looking at how well any of the code predictions compared to the test results. It was a test of how similar the two input methods were to one another, not a test of how well the simulation predicted the true engine performance. In the case of the simulations run at the design point of the engine, the results differed by less than 4 percent from one another in the prediction of indicated power. It was felt that this was smaller than the experimental error incurred in the measurement of indicated power and was therefore valid.

This style of data presentation may not be valid for other FPSE engines. The reason that it works well for the RE-1000 is due to the power piston being quite massive and therefore tending to have a sinusoidal motion with little of any higher harmonics. This is reinforced by the load being a pure damper unit which has sinusoidal load characteristics. The same would most likely not be true for a load like the hydraulic pump being tested at NASA Lewis, since the force exerted on the engine is far from sinusoidal. More about the hydraulic load can be found in reference 14. The hydraulic load can cause the engine motions to become highly nonsinusoidal in nature.

Another topic that warrants discussion is the use of the heater tube temperature measurements. The heater tubes of the RE-1000 are heated by resistance heating. The heat is generated inside the heater tube walls. An insulation blanket was placed around the heater head to help prevent heat losses from the head to the surroundings. The thermocouples used to measure the heater tube temperatures were mounted on the outside surface of the tubes indicated in figure 23 and can be seen installed on the heater head in figure 5. If the insulation around the heater head was perfect and with no loss of heat from the head, the temperature gradient through the wall of the heater tube would be flat at the outer surface of the tube. This is very different from the situation that normally exists in Stirling engines where the

heat input is from a combustion source. Since the insulation around the heater head was not perfect, there was some loss of heat from the heater tubes to the atmosphere around the engine. Therefore a temperature gradient exists at the outer surface of the tube that conducts heat toward the outer surface. This creates a point at some distance inside the tube material with a higher temperature than the measured outer wall temperature. The temperature at the inner surface of the heater tube would, as expected, be at some lower temperature because the working fluid is absorbing heat. Figure 29 shows the temperature gradients in these cases discussed.

It would increase the accuracy of a simulation if a correction method was implemented for inputting the measured outer wall temperature. The correction should account for the temperature gradient in a resistance heated tube being different than the gradient in a combustion heated tube. A comparison of the measured expansion space mean gas temperature to the calculated values may provide a means of assuring a correct simulation of the heater temperature.

It was found during these tests that even the measurement of the mean pressure level of the engine needs to be interpreted properly for best results. These measurements were made with strain gauge pressure transducers connected to the engine by means of stainless steel tubing. A small orifice was inserted into each of the stainless steel tubes used for the two mean pressure measurements. In the case of the mean working space measurement, the orifice was a micrometer needle valve with a taper of 1° on the needle. This orifice size could therefore be adjusted as the engine was running. It was found that the reading of the mean pressure could be distorted by changing the size of the orifice. If the orifice was too big, some of the pressure wave present in the engine would get to the transducer and make the output of the transducer fluctuate at the operating frequency of the engine. If the orifice size became too small, the reading of the mean pressure would become higher without the actual engine pressure being raised.

This phenomenon was caused by the change in the density of the working fluid during an engine cycle. If the mean pressure in the engine and the pressure in the transducer were at the exact same level at the initiation of a cycle, there would be the same volumetric flow of gas from the engine to the transducer during the high pressure half of the cycle as the volumetric flow from the transducer to the engine during the low pressure half of the cycle. Due to the change in the density of the gas in the working space during the cycle, the mass flow would not be the same in both directions. This causes a net mass flow of gas toward the transducer which continues until the mean pressure in the transducer is above the mean pressure in the engine to force the net mass flow to become zero.

To prove that this actually did effect the pressure readings of the engine, the output signals of the mean pressure transducers were connected to a strip chart recorder to record the pressure readings versus time. With the engine running at a steady-state condition, the orifice size of the mean compression space transducer (MEANCP), was varied. As the orifice size was reduced, the output signal of the transducer increased. As the orifice size was increased, the output signal was lowered until a point was reached where the pressure wave of the engine started to show in the output signal of the transducer. During this test the output of the mean bounce space pressure transducer (MEANBP), was observed to remain constant.

Because of these results, it may be more accurate to use the value of MEANBP as a representation of the true mean pressure level of the engine. This transducer is less susceptible to this sort of error because the pressure wave in the bounce space is extremely small in the RE-1000. The true mean pressure of the working space should be higher than that of the bounce space only by the amount needed to support the weight of the power piston. The pressure required is about 20.9 kPa (3.03 psi) for the standard power piston.

During the recording of some data points, 1020 to 1025, a failure in the thermocouples that measured the temperature differential of the water used to cool the engine resulted in erroneous calculations of the heat rejection from the engine cooler. These readings were for a series of points with the average heater tube temperature set at 500 °C. Figure 30 shows the recorded values of cooler heat rejection versus the power piston stroke. The 500 °C curve clearly does not follow the trends of the other curves. By using a curve fitting technique applied to the data points with the heater tube average temperature set at 450, 550, and 600 °C, values for the heat rejected during the 500 °C run were predicted. The predicted values of heat rejection are also plotted. In addition, figure 30 shows the measured and predicted values of the engine efficiency plotted as a function of heater temperature and piston stroke. From the closeness of the curve fitting technique used, it is felt that these analytical values are valid when coupled with the experimental data.

On some data points, the instrumentation used to measure QCOOLR proved to be correct while the trends of the internal efficiency were opposite to the expected classical Stirling engine trends. It was noted that as the cooling water inlet temperature was raised the calculation of INTEFF diverted from the calculation of EXTEFF. The only difference between the two methods used to calculate the engine brake efficiency was the representation of the heat input to the engine system. EXTEFF was based on the electric power supplied to the heater head while INTEFF was based on the summation of the power and heat flowing out of the engine system. The calculated values of efficiency agreed well with one another for data with the cooling water inlet temperature at 25 °C, however, their values diverged as the cooling water inlet temperature was raised to the values of 40 and 55 °C .

It was found that when the cooling water inlet temperature was at 25 °C, there was little heat transferred between the cooler housing and the atmosphere around the engine. At elevated cooling water temperatures some heat was lost directly from the cooler housing to the atmosphere without being detected as an increase in the cooling water temperature as it passed through the cooler. To derive a correction for this measurement would require an assumption to be made so that the heat transfer from the cooler housing to the atmosphere could be calculated. It is best to exclude the use of data points having elevated cooling water inlet temperatures when accurate energy balances are required.

CONCLUDING REMARKS

The effort to complete the sensitivity tests at the NASA Lewis test facility has been completed. A matrix with 8 parameters varied was used to determine the test conditions. The RE-1000 provided a reliable test bed for the investigation of the thermodynamics of the Stirling cycle along with the dynamics of a free-piston engine. Throughout the test program the engine

demonstrated high reliability. Most of the problems encountered involved the instrumentation used to measure the engine performance.

A complete characterization of the engine performance has been recorded and is presented in this report for the purpose of Stirling cycle computer code validation. Some of the measurements made can be of great help in understanding the losses of the Stirling cycle. For some of the data points recorded, the amplitude of the dynamic pressure drop through the heat exchangers was recorded. The measurement technique used for the dynamic pressure drop had to be perfected and therefore was not made during the initial stages of the test program. However, steady-state flow tests were performed on all of the heat exchangers used in the program. During tests utilizing one of the two displacers, the amplitude of the gas pressure inside of the displacer gas spring was recorded. Due to the nonlinearity of a gas spring, this parameter can be of great use in the computer simulation validation process.

SUMMARY OF RESULTS

The data are generally quite accurate and lend themselves well to validation purposes, especially when used as per the recommendations outlined in this report. Because there is some error associated with the measurement of any experimental parameter, care must be used when validating a computer simulation. A rough indication of the error of each measurement and calculation is given in this report.

The RE-1000 was designed to be a reliable, research engine intended to provide easy access to key areas for measurements of critical parameters. This engine was not optimized as a complete engine for high power or for high efficiency. The sensitivity test program did however obtain the following results:

1. The trends contained in the data agree well with the theoretical rules of Stirling engine performance. Power output and efficiencies measured act in accordance with previous engine tests.
2. The test program investigated many characteristics of the engine.
 - a. Tests were completed over a test matrix which varied the mean operating pressure to three levels, the heater temperature to four levels, the cooler temperature to three levels, both the regenerator porosity and the displacer dynamics to two different values, the power piston mass to two values and used three different working fluids. In addition, the power piston stroke was varied over its range for each of the operating conditions.
 - b. In the nearly 200 hr of operation accumulated during the sensitivity tests, the engine proved itself to be a reliable test bed for research. The engine was usually found to be more reliable than the instrumentation and supporting data system.
 - c. During the course of the testing, some novel instrumentation was added to provide a better insight into the operation of the free-piston engine. These measurements included the dynamic pressure drop transducers and the dynamic pressure reading of the displacer gas spring.

d. Steady-state flow tests were performed to enable a correlation between these measurements and the dynamic pressure drop measurements to be made. Although the dynamic pressure drop transducers were working only for the tests performed with one of the two regenerators used, this should still prove to be of great benefit in the validation of computer codes.

APPENDIX A

Heat Exchanger Steady-State Flow Tests

Steady-state flow tests were performed on the RE-1000 heat exchanger assembly. These tests were done for the engine with both of the regenerators used in the sensitivity tests. The two regenerators tested were of 75.9 percent porosity and of 81.2 percent porosity. The tests were run with nitrogen at mass flow rates that gave approximately the Reynolds numbers that occur in the engine during operation.

The pressure drops were measured with the Validyne differential pressure transducers that were installed on the engine for the dynamic pressure drop measurements. The cooler pressure drop and the regenerator pressure drop were measured directly with the transducers installed. The heater pressure drop was calculated from a measurement of the total pressure drop across the heat exchanger assembly, minus the regenerator and cooler pressure drops. The tests were run from zero flow rate, up to the maximum flow desired and back down to zero flow again. If the transducers did not return to zero pressure drop at zero flow, the transducers were adjusted and the tests were rerun.

Tests were run with the mean pressure at either 1380 kPa (200 psi) or at 2070 kPa (300 psi) depending on the requirements of the flow meters being used for the particular test. The mass flow rates were measured with venturi-type flow meters. The measurements of flow rate were corrected for the variations in the temperature of the nitrogen.

The results of these flow tests are presented in the form of graphs of the pressure drops measured versus the mass flow rate. These plots are shown in figure 7 for the tests with regenerator 1 (75.9 percent porosity) and in figure 8 for regenerator 2 (81.2 percent porosity).

APPENDIX B

Data System Calculations

All of the calculations used in the data system are presented in this appendix. For each of the calculations, the parameters used as inputs are listed, the calculation is shown, and an estimate of the error of the calculation is given. The error is based on the estimated errors of the input parameters and was calculated by methods outlined in reference 11. The error of the calculation corresponds to the design point of the engine, data point 1010. A second error calculation is presented that corresponds to data point 1099. This shows the error in the calculations at a low power operating condition. The inputs to the calculations are listed in terms of their mnemonics and can be found in the list of instrumentation in table IV.

CALCULATION 1

ELECTRICAL POWER INPUT (WATTS)

$$\text{power} = \text{voltage} \times \text{current}$$

$$\text{PWRIN} = \text{voltg} \times \text{amps}$$

VOLTG heater head voltage (volts)
AMPS calculation 8 (amps)

$$\text{ERROR} = [(0.01)^2 + (0.02)^2]^{1/2}$$

$$\text{ERROR} = 2\% \quad (73 \text{ W})$$

$$(\text{ERROR} = 4\% @ \text{POINT } 1099)$$

CALCULATION 2

HEAT TO THE COOLING WATER BY THE COOLER (WATTS)

$$\text{heat} = (\text{mass flow}) (\text{specific heat}) (\text{delta temp})$$

$$QCOOLR = \frac{(\text{FLOCLR}) (\text{RHOH}_2\text{O}) (\text{CPH}_2\text{O}) (\text{TDLCLR})}{60}$$

FLOCLR cooling water volumetric flow rate (l/min)
RHOH₂O water density sub-routine (gm/l)
CPH₂O water specific heat sub-routine (joules/gm °C)
TDLHTR cooling water delta temperature (°C)

$$\text{ERROR} = [(0.1/4.22)^2 + (0.2/9.34)^2]^{1/2}$$

$$\text{ERROR} = 3\% \quad (82 \text{ W})$$

$$(\text{ERROR} = 6\% @ \text{POINT } 1099)$$

CALCULATION 3

HEAT TO THE COOLING WATER BY THE DASHPOT (WATTS)

$$\text{heat} = (\text{mass flow}) (\text{specific heat}) (\text{delta temp})$$

$$QDSHPT = \frac{(\text{FLODP}) (\text{RHOH}_2\text{O}) (\text{CPH}_2\text{O}) (\text{TDLDP})}{60}$$

FLODP dashpot water volumetric flow rate (l/min)
RHOH₂O water density sub-routine (gm/l)
CPH₂O water specific heat sub-routine (joules/gm °C)
TDLDP dashpot water delta temperature (°C)

$$\text{ERROR} = [(0.1/3.96)^2 + (0.2/2.21)^2]^{1/2}$$

$$\text{ERROR} = [(0.1/3.96)^2 + (0.2/2.21)^2]^{1/2}$$

$$\text{ERROR} = 9\% \quad (55 \text{ W})$$

(ERROR = 51% @ 1099)

CALCULATION 4

BRAKE ENGINE EFFICIENCY, EXTERNAL (%)

$$\text{efficiency} = \frac{\text{brake power output}}{\text{electric power input}}$$

$$\text{EXTEFF} = \frac{\text{PWROUT}}{\text{PWRIN}}$$

PWROUT brake power output, analog circuit (W)
PWRIN electric heater power input (W)

$$\text{ERROR} = [(0.03)^2 + (0.02)^2]^{1/2}$$

$$\text{ERROR} = 4\%$$

(ERROR = 6% @ POINT 1099)

CALCULATION 5

AVERAGE HEATER TUBE TEMPERATURE (°C)

$$\text{temperature} = \frac{\text{summation of 12 tube temps}}{12}$$

$$\text{TAVHTR} = \frac{\text{summation T01HTR to T12HTR}}{12}$$

TxxHTR heater tube outside wall temperature (°C)

$$\text{ERROR} = [12(10/600)^2]^{1/2}$$

$$\text{ERROR} = 6\% \quad (36 \text{ °C})$$

(ERROR = 8% @ POINT 1099)

CALCULATION 6

BRAKE ENGINE EFFICIENCY, INTERNAL (%)

$$\text{efficiency} = \frac{\text{brake power output}}{\text{brake power} + \text{heat rejected}}$$

$$\text{INTEFF} = \frac{\text{PWROUT}}{\text{PWROUT} + \text{QCOOLR}}$$

PWROUT brake power output, analog circuit (W)
QCOOLR heat rejected by the engine cooler (W)

$$\text{ERROR} = [(0.03)^2 + (0.03)^2 + (0.03)^2]^{1/2}$$

$$\text{ERROR} = 5\%$$

(ERROR = 9% @ POINT 1099)

CALCULATION 8

HEATER AMPERAGE ($^{\circ}\text{C}$)

$$\text{amperage} = \text{amperage 1} + \text{amperage 2}$$

$$\text{AMPS} = \text{AMPS1} + \text{AMPS2}$$

AMPS1 amperage from power supply 1 (A)
AMPS2 amperage from power supply 2 (A)

$$\text{ERROR} = [(10/673)^2 + (10/618)^2]^{1/2}$$

$$\text{ERROR} = 2\% \quad (28 \text{ A})$$

(ERROR = 4% @ POINT 1099)

CALCULATION 9

DISPLACER GAS CONDUCTION (WATTS)

$$\text{heat} = (\text{gas conductivity}) (\text{conduction area}) (\text{delta temp})$$

$$QDISPG = (\text{Kg}) (2.76) (\text{TGEXP}-\text{TGCOMP})$$

Kg gas conductivity ($\text{W/cm } ^{\circ}\text{C}$)
2.76 cross section of gas (cm^2)
TGEXP expansion space gas temperature ($^{\circ}\text{C}$)
TGCOMP compression space gas temperature ($^{\circ}\text{C}$)

$$\text{ERROR} = \frac{10 + 1}{(557-56)}$$

$$\text{ERROR} = 2\% \quad (0.06 \text{ W})$$

(ERROR = 3% @ POINT 1099)

CALCULATION 10

DISPLACER SHELL CONDUCTION (WATTS)

$$\text{heat} = (\text{shell conductivity}) (\text{conduction area}) (\text{delta temp})$$

$$QDISP = (Km) (0.0284) (TGEXP - TGCOMP)$$

Km displacer metal conductivity (W/cm °C)
0.00284 conduction area (cm²)
TGEXP expansion space gas temperature (°C)
TGCOMP compression space gas temperature (°C)

$$\text{ERROR} = \frac{10 + 1}{(557-56)}$$

$$\text{ERROR} = 2\% \quad (0.28 \text{ W})$$

(ERROR = 3% @ POINT 1099)

CALCULATION 11

REGENERATOR WALL CONDUCTION, COOL END (WATTS)

$$\text{heat} = (Km) (\text{conduction area}) (\Delta \text{temp})$$

$$QREG1 = 0.811 (T18REG - T19REG)$$

0.811 metal conductivity times conduction area (W cm/°C)
T18REG regenerator wall temperature, midpoint (°C)
T19REG regenerator wall temperature, cool end (°C)

$$\text{ERROR} = \frac{5 + 5}{(339-221)}$$

$$\text{ERROR} = 8\% \quad (7.7 \text{ W})$$

(ERROR = 9% @ POINT 1099)

CALCULATION 12

REGENERATOR WALL CONDUCTION, COOL END (WATTS)

$$\text{heat} = (Km) (\text{conduction area}) (\Delta \text{temp})$$

$$QREG2 = 0.811 (T14REG - T18REG)$$

0.811 metal conductivity times conduction area (W/cm °C)
T14REG regenerator wall temperature, hot end (°C)
T18REG regenerator wall temperature, midpoint (°C)

$$\text{ERROR} = \frac{10 + 5}{(339-221)}$$

$$\text{ERROR} = 9\% \quad (12.5 \text{ W})$$

(ERROR = 13% @ POINT 1099)

CALCULATION 13

INNER REGENERATOR WALL CONDUCTION (WATTS)

heat = (Km) (conduction area) (delta temp)

$$QREG3 = 0.0774 (TGREGH - TGREGC)$$

0.0774 metal conductivity times conduction area (W cm/ $^{\circ}$ C)
TREGH regenerator hot end gas temperature ($^{\circ}$ C)
TREGC regenerator cold end gas temperature ($^{\circ}$ C)

$$\text{ERROR} = \frac{10 + 1}{(549 - 91)}$$

$$\text{ERROR} = 2\% \quad (0.7 \text{ W})$$

(ERROR = 3% @ POINT 1099)

CALCULATION 14

PRESSURE FACTOR OF THE POWER PISTON (kPa/cm)

factor = $\frac{(\text{compression space pressure amplitude}) \text{ (trig term)}}{(\text{piston amplitude})}$

$$PFP = \frac{2(PAMPC) (\cos \theta_p + (\sin \theta_p / \tan \theta_d))}{(PISTST)}$$

PAMPC pressure amplitude in the compression space (kPa)
 θ_p phase angle, pressure to power piston (deg)
PISTST power piston stroke (cm)

$$\text{ERROR} = 3\%$$

(ERROR = 5% @ POINT 1099)

CALCULATION 15

PRESSURE FACTOR OF THE DISPLACER (kPa/cm)

factor = $\frac{(\text{compression space pressure amplitude}) \text{ (trig term)}}{(\text{displacer amplitude})}$

$$PFD = \frac{(PAMPC) (\sin \theta_p)^2}{(DISPST) (\sin \theta_d)}$$

PAMPC pressure amplitude in the compression space (kPa)
 θ_p phase angle, pressure to power piston (deg)
DISPST displacer stroke (cm)
 θ_d phase angle, displacer to power piston (deg)

ERROR = 2%

(ERROR = 4% @ POINT 1099)

CALCULATION 16

BEALE NUMBER

$$\text{number} = \frac{\text{brake power output}}{(\text{mean pressure}) (\text{swept volume}) (\text{frequency})}$$

$$N_{BEALE} = \frac{(100) \text{ PWR}OUT}{(\text{MEANBP}) (\text{PISTST}) (\text{AREA}) (\text{FREQ})}$$

PWR_{OUT} brake power output, analog circuit (W)
MEANBP mean bounce space pressure (kPa)
PISTST power piston stroke (cm)
AREA cross section area of the power piston (cm²)
FREQ operating frequency of the engine (Hz)

ERROR = 3%

(ERROR = 5% @ POINT 1099)

APPENDIX C

Double Variable Data Set, (DVDS)

Listing of the DVDS are presented in this appendix. These data points were determined by letting the stroke of the power piston be varied over its range for each one of the data points of the Single Variable Data Set (SVDS). The format of the listing is the same as used for the SVDS.

APPENDIX C. - DOUBLE VARIABLE DATA SET, (DVDS)

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 11/17/83 09:56:39.76 RDG 598

FLUID HELIUM BAROM 14.268 PSI REGENERATOR 2 DISPLACER 1 STANDARD PISTON

HEAT TO DASHPOT COOLING FLODP 4.17 L/MIN	POWER IN AMPS1 606. AMPS AMPS2 535. AMPS VOLTG 2.50 VOLTS	ENGINE CHARGE PRESSURE PRESUP 7411. KPA MEANBP 7003. KPA MEANCP 7026. KPA	GAS TEMPERATURES TGEXP 566.0 DEG.C TGREGH 547.6 DEG.C TGREGC 96.2 DEG.C TGCOMP 45.7 DEG.C TGBOUN 28.7 DEG.C	SURFACE TEMPERATURES T01HTR 591.2 DEG.C T02HTR 617.6 DEG.C T03HTR 610.5 DEG.C T04HTR 602.9 DEG.C T05HTR 609.2 DEG.C T06HTR 586.2 DEG.C T07HTR 586.5 DEG.C T08HTR 604.9 DEG.C T09HTR 621.1 DEG.C T10HTR 552.6 DEG.C T11HTR 601.0 DEG.C T12HTR 609.9 DEG.C
HEAT TO COOLER FLOCRL 4.02 L/MIN TWINCL 24.8 DEG.C TDLCL 6.42 DEG.C TWOCLR 31.19 DEG.C	CALCULATED PARAMETERS 1 PWPIR 2848. WATTS 2 QCOOLR 1789. WATTS 3 QDSHPT 450. WATTS 4 EXTEFF 24.9 % 5 TAVHTR 599.5 DEG.C 6 IMTEFF 28.4 % 8 AMPS 1140. AMPS 9 QDISPG 3. WATTS 10 QDISP 15. WATTS 11 QREG1 103. WATTS 12 QREG2 122. WATTS 13 QREG3 35. WATTS 14 PFP 1024.5 KPA/CM 15 PFD 385.1 KPA/CM 16 NBEALE 0.00741	VIBRATION VX1HOR 0.4 CM/S VY1VER 5.7 CM/S PHASE ANGLES PADISP 54.7 DEG. PAPRES -27.1 DEG. ENGINE SPEED FREQ 29.9 HZ	REMOTE CALCULATIONS PWROUT 709. WATTS INDPWR 739. WATTS PISTST 1.78 CM DISPST 2.18 CM DYNAMIC CALCULATIONS PAMPC 753. KPA DISPCP 1.89 CM PISTCP 2.50 CM PDYNDB***** KPA PDLCLR***** KPA PDLRREG***** KPA PDLDIS***** KPA	T13REG 566.3 DEG.C T14REG 532.1 DEG.C T15REG 406.3 DEG.C T16REG***** DEG.C T17REG 357.7 DEG.C T18REG 381.5 DEG.C T19REG 254.3 DEG.C T03HED 221.0 DEG.C

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 11/17/83 10:01:48.78 RDG 599

FLUID HELIUM BAROM 14.268 PSI REGENERATOR 2 DISPLACER 1 STANDARD PISTON

HEAT TO DASHPOT COOLING FLODP 4.16 L/MIN	POWER IN AMPS1 643. AMPS AMPS2 568. AMPS VOLTG 2.65 VOLTS	ENGINE CHARGE PRESSURE PRESUP 7147. KPA MEANBP 6996. KPA MEANCP 7019. KPA	GAS TEMPERATURES TGEXP 563.3 DEG.C TGREGH 547.3 DEG.C TGREGC 99.6 DEG.C TGCOMP 49.4 DEG.C TGBOUN 30.1 DEG.C	SURFACE TEMPERATURES T01HTR 594.8 DEG.C T02HTR 614.9 DEG.C T03HTR 612.3 DEG.C T04HTR 601.6 DEG.C T05HTR 607.2 DEG.C T06HTR 589.3 DEG.C T07HTR 583.0 DEG.C T08HTR 604.1 DEG.C T09HTR 622.0 DEG.C T10HTR 550.5 DEG.C T11HTR 601.0 DEG.C T12HTR 607.2 DEG.C

HEAT TO COOLER FLOCRL 4.06 L/MIN TWINCL 24.9 DEG.C TDLCL 7.14 DEG.C TWOCLR 32.02 DEG.C	CALCULATED PARAMETERS 1 PWPIR 3214. WATTS 2 QCOOLR 2010. WATTS 3 QDSHPT 531. WATTS 4 EXTEFF 26.1 % 5 TAVHTR 599.0 DEG.C 6 IMTEFF 29.4 % 8 AMPS 1212. AMPS 9 QDISPG 3. WATTS 10 QDISP 15. WATTS 11 QREG1 101. WATTS 12 QREG2 123. WATTS 13 QREG3 35. WATTS 14 PFP 1015.6 KPA/CM 15 PFD 376.6 KPA/CM 16 NBEALE 0.00783	VIBRATION VX1HOR 0.4 CM/S VY1VER 6.4 CM/S PHASE ANGLES PADISP 55.4 DEG. PAPRES -25.6 DEG. ENGINE SPEED FREQ 29.8 HZ	REMOTE CALCULATIONS PWROUT 839. WATTS INDPWR 878. WATTS PISTST 2.00 CM DISPST 2.36 CM DYNAMIC CALCULATIONS PAMPC 846. KPA DISPCP 1.99 CM PISTCP 2.58 CM PDYNDB***** KPA PDLCLR***** KPA PDLRREG***** KPA PDLDIS***** KPA	T13REG 563.8 DEG.C T14REG 529.8 DEG.C T15REG 404.5 DEG.C T16REG***** DEG.C T17REG 364.9 DEG.C T18REG 378.5 DEG.C T19REG 254.0 DEG.C T03HED 248.6 DEG.C

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 11/17/83 10:06:54.78 RDG 600

FLUID HELIUM BAROM 14.268 PSI REGENERATOR 2 DISPLACER 1 STANDARD PISTON

HEAT TO DASHPOT COOLING FLODP 4.13 L/MIN	POWER IN AMPS1 692. AMPS AMPS2 607. AMPS VOLTG 2.84 VOLTS	ENGINE CHARGE PRESSURE PRESUP 7428. KPA MEANBP 7001. KPA MEANCP 7031. KPA	GAS TEMPERATURES TGEXP 562.2 DEG.C TGREGH 547.8 DEG.C TGREGC 103.0 DEG.C TGCOMP 53.5 DEG.C TGBOUN 32.1 DEG.C	SURFACE TEMPERATURES T01HTR 599.6 DEG.C T02HTR 617.4 DEG.C T03HTR 617.2 DEG.C T04HTR 603.1 DEG.C T05HTR 610.3 DEG.C T06HTR 592.9 DEG.C T07HTR 584.0 DEG.C T08HTR 606.1 DEG.C T09HTR 625.6 DEG.C T10HTR 550.1 DEG.C T11HTR 603.6 DEG.C T12HTR 609.4 DEG.C

HEAT TO COOLER FLOCRL 4.09 L/MIN TWINCL 25.0 DEG.C TDLCL 8.09 DEG.C TWOCLR 33.11 DEG.C	CALCULATED PARAMETERS 1 PWPIR 3684. WATTS 2 QCOOLR 2296. WATTS 3 QDSHPT 622. WATTS 4 EXTEFF 26.5 % 5 TAVHTR 601.6 DEG.C 6 IMTEFF 29.8 % 8 AMPS 1299. AMPS 9 QDISPG 3. WATTS 10 QDISP 14. WATTS 11 QREG1 101. WATTS 12 QREG2 121. WATTS 13 QREG3 34. WATTS 14 PFP 1027.1 KPA/CM 15 PFD 372.6 KPA/CM 16 NBEALE 0.00823	VIBRATION VX1HOR 0.5 CM/S VY1VER 7.2 CM/S PHASE ANGLES PADISP 56.1 DEG. PAPRES -24.1 DEG. ENGINE SPEED FREQ 29.9 HZ	REMOTE CALCULATIONS PWROUT 976. WATTS INDPWR 1021. WATTS PISTST 2.21 CM DISPST 2.52 CM DYNAMIC CALCULATIONS PAMPC 955. KPA DISPCP 2.01 CM PISTCP 2.58 CM PDYNDB***** KPA PDLCLR***** KPA PDLRREG***** KPA PDLDIS***** KPA	T13REG 564.7 DEG.C T14REG 530.9 DEG.C T15REG 405.9 DEG.C T16REG***** DEG.C T17REG 368.4 DEG.C T18REG 381.4 DEG.C T19REG 256.9 DEG.C T03HED 276.8 DEG.C

APPENDIX C. - CONTINUED.

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 11/17/83 10:12:06.78 RDG 601

FLUID HELIUM		BAROM 14.268 PSI REGENERATOR 2 DISPLACER 1 STANDARD PISTON				
HEAT TO DASHPOT COOLING		POWER IN		ENGINE CHARGE PRESSURE		GAS TEMPERATURES
FLODP	4.12 L/MIN	AMPS1	742. AMPS	PRESUP	7134. KPA	TGEXP 557.6 DEG.C
		AMPS2	627. AMPS			T01HTR 598.3 DEG.C
TWINDP	17.1 DEG.C	VOLTG	2.98 VOLTS	MEANBP	6983. KPA	T02HTR 615.7 DEG.C
TDLDP	2.55 DEG.C			MEANCP	7021. KPA	T03HTR 616.6 DEG.C
TWODPR	20.2 DEG.C					T04HTR 599.0 DEG.C
						T05HTR 609.3 DEG.C
						T06HTR 590.2 DEG.C
						T07HTR 580.9 DEG.C
						T08HTR 603.6 DEG.C
						T09HTR 622.6 DEG.C
						T10HTR 545.0 DEG.C
						T11HTR 601.4 DEG.C
						T12HTR 607.7 DEG.C
HEAT TO COOLER		CALCULATED PARAMETERS		VIBRATION		REMOTE CALCULATIONS
FLOCLR	4.13 L/MIN	1 PWRIIN	4030. WATTS	VX1HOR	0.5 CM/S	PWRROUT 1077. WATTS
TWINCL	25.1 DEG.C	2 QCOOLR	2589. WATTS	VY1VER	7.8 CM/S	INDPWR 1125. WATTS
TDLCL	9.05 DEG.C	3 QDSHPT	730. WATTS			PISTST 2.38 CM
TWOCLR	34.11 DEG.C	4 EXTEFF	26.4 %			DISPST 2.65 CM
		5 TAVHTR	599.2 DEG.C			DYNAMIC CALCULATIONS
		6 INTEFF	29.4 %	PADISP	57.1 DEG.	PAMPC 546. KPA
		8 AMPS	1369. AMPS	PAPRES	-22.5 DEG.	DISPCP 2.05 CM
		9 QDISPG	3. WATTS			PISTCP 2.56 CM
		10 QDISP	14. WATTS	ENGINE SPEED		PDYNDB***** KPA
		11 QREG1	102. WATTS	FREQ	29.9 HZ	PDLCLR***** KPA
		12 QREG2	120. WATTS			PDLREG***** KPA
		13 QREG3	34. WATTS			PDLDIS***** KPA
		14 PFP	537.5 KPA/CM			
		15 PFD	188.0 KPA/CM			
		16 NBEALE	0.00843			

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 11/17/83 10:17:21.80 RDG 602

FLUID HELIUM		BAROM 14.268 PSI REGENERATOR 2 DISPLACER 1 STANDARD PISTON				
HEAT TO DASHPOT COOLING		POWER IN		ENGINE CHARGE PRESSURE		GAS TEMPERATURES
FLODP	4.10 L/MIN	AMPS1	776. AMPS	PRESUP	7482. KPA	TGEXP 554.8 DEG.C
		AMPS2	651. AMPS			T01HTR 609.3 DEG.C
TWINDP	17.3 DEG.C	VOLTG	3.11 VOLTS	MEANBP	7013. KPA	T02HTR 609.9 DEG.C
TDLDP	2.94 DEG.C			MEANCP	7056. KPA	T03HTR 619.7 DEG.C
TWODPR	20.9 DEG.C					T04HTR 594.8 DEG.C
						T05HTR 604.4 DEG.C
						T06HTR 602.3 DEG.C
						T07HTR 573.2 DEG.C
						T08HTR 605.9 DEG.C
						T09HTR 619.2 DEG.C
HEAT TO COOLER		CALCULATED PARAMETERS		VIBRATION		REMOTE CALCULATIONS
FLOCLR	4.17 L/MIN	1 PWRIIN	4433. WATTS	VX1HOR	0.5 CM/S	PWRROUT 1216. WATTS
TWINCL	25.2 DEG.C	2 QCOOLR	2789. WATTS	VY1VER	8.5 CM/S	INDPWR 1262. WATTS
TDLCL	9.63 DEG.C	3 QDSHPT	840. WATTS			PISTST 2.58 CM
TWOCLR	34.80 DEG.C	4 EXTEFF	27.4 %			DISPST 2.72 CM
		5 TAVHTR	599.3 DEG.C			DYNAMIC CALCULATIONS
		6 INTEFF	30.4 %	PADISP	57.1 DEG.	PAMPC 1127. KPA
		8 AMPS	1427. AMPS	PAPRES	-21.6 DEG.	DISPCP 2.11 CM
		9 QDISPG	3. WATTS			PISTCP 2.64 CM
		10 QDISP	14. WATTS	ENGINE SPEED		PDYNDB***** KPA
		11 QREG1	106. WATTS	FREQ	29.9 HZ	PDLCLR***** KPA
		12 QREG2	121. WATTS			PDLREG***** KPA
		13 QREG3	34. WATTS			PDLDIS***** KPA
		14 PFP	1019.5 KPA/CM			
		15 PFD	362.7 KPA/CM			
		16 NBEALE	0.00875			

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 07/26/84 15:35:55.03 RDG 1006

FLUID HELIUM		BAROM 14.303 PSI REGENERATOR 1 DISPLACER 1 STANDARD PISTON				
HEAT TO DASHPOT COOLING		POWER IN		ENGINE CHARGE PRESSURE		GAS TEMPERATURES
FLODP	3.96 L/MIN	AMPS1	534. AMPS	PRESUP	7365. KPA	TGEXP 567.8 DEG.C
		AMPS2	503. AMPS			T01HTR 601.6 DEG.C
TWINDP	17.7 DEG.C	VOLTG	2.25 VOLTS	MEANBP	7011. KPA	T02HTR 605.5 DEG.C
TDLDP	1.15 DEG.C			MEANCP	7040. KPA	T03HTR 612.6 DEG.C
TWODPR	1.6 DEG.C					T04HTR 606.4 DEG.C
						T05HTR 614.3 DEG.C
						T06HTR 606.3 DEG.C
						T07HTR 604.5 DEG.C
						T08HTR 584.1 DEG.C
						T09HTR 608.8 DEG.C
HEAT TO COOLER		CALCULATED PARAMETERS		VIBRATION		REMOTE CALCULATIONS
FLOCLR	4.22 L/MIN	1 PWRIIN	2338. WATTS	VX1HOR	0.2 CM/S	PWRROUT 532. WATTS
TWINCL	24.7 DEG.C	2 QCOOLR	1892. WATTS	VY1VER	5.9 CM/S	INDPWR 570. WATTS
TDLCL	6.47 DEG.C	3 QDSHPT	317. WATTS			PISTST 1.80 CM
TWOCLR	29.47 DEG.C	4 EXTEFF	22.7 %			DISPST 1.83 CM
		5 TAVHTR	599.6 DEG.C			DYNAMIC CALCULATIONS
		6 INTEFF	21.9 %	PADISP	56.0 DEG.	PAMPC 792. KPA
		8 AMPS	1037. AMPS	PAPRES	-19.8 DEG.	DISPCP 2.13 CM
		9 QDISPG	3. WATTS			PISTCP 2.31 CM
		10 QDISP	15. WATTS	ENGINE SPEED		PDYNDB***** KPA
		11 QREG1	119. WATTS	FREQ	30.2 HZ	PDLCLR 3.22 KPA
		12 QREG2	118. WATTS			PDLREG 37.33 KPA
		13 QREG3	37. WATTS			PDLDIS 65.16 KPA
		14 PFP	1029.1 KPA/CM			
		15 PFD	353.7 KPA/CM			
		16 NBEALE	0.00544			

APPENDIX C. - CONTINUED.

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 07/26/84 15:40:22.06 RDG 1007

FLUID HELIUM BAROM 14.303 PSI REGENERATOR 1 DISPLACER 1 STANDARD PISTON

HEAT TO DASHPOT COOLING FLODP 3.94 L/MIN	POWER IN AMPS1 571. AMPS AMPS2 533. AMPS VOLTG 2.40 VOLTS	ENGINE CHARGE PRESSURE PRESUP 7469. KPA MEANBP 6982. KPA MEANCP 7013. KPA	GAS TEMPERATURES TGEXP 564.8 DEG.C TGREGH 563.7 DEG.C TGREGC 92.6 DEG.C TGCOMP 42.0 DEG.C TGBOUN 29.0 DEG.C	SURFACE TEMPERATURES T01HTR 602.6 DEG.C T02HTR 605.0 DEG.C T03HTR 613.7 DEG.C T04HTR 605.5 DEG.C T05HTR 615.7 DEG.C T06HTR 607.1 DEG.C T07HTR 605.4 DEG.C T08HTR 583.8 DEG.C T09HTR 609.7 DEG.C T10HTR 590.4 DEG.C T11HTR 577.8 DEG.C T12HTR 577.7 DEG.C
HEAT TO COOLER FLOCLR 4.24 L/MIN TWINCL 24.7 DEG.C TDLCL 6.82 DEG.C TWOCLR 29.95 DEG.C	CALCULATED PARAMETERS 1 PWRIN 2648. WATTS 2 QCOOLR 2004. WATTS 3 QDSHPT 390. WATTS 4 EXTEFF 23.5 % 5 TAVHTR 599.5 DEG.C 6 INTEFF 23.7 % 8 AMPS 1104. AMPS 9 QDISPG 3. WATTS 10 QDISP 15. WATTS 11 QREG1 118. WATTS 12 QREG2 117. WATTS 13 QREG3 36. WATTS 14 PFP 1018.7 KPA/CM 15 PFD 345.8 KPA/CM 16 NBEALE 0.00573	VIBRATION VX1HOR 0.3 CM/S VY1VER 6.6 CM/S PHASE ANGLES PADISP 56.6 DEG. PAPRES -18.9 DEG. ENGINE SPEED FREQ 30.2 HZ	REMOTE CALCULATIONS FWROUT 622. WATTS INDFWR 665. WATTS PISTST 2.01 CM DISPST 1.97 CM DYNAMIC CALCULATIONS PAMPC 881. KPA DISPCP 2.24 CM PISTCP 2.34 CM PDYNDB***** KPA PDLCLR 3.73 KPA PDLREG 42.43 KPA PDLDIS 73.65 KPA	T13REG***** DEG.C T14REG 517.9 DEG.C T15REG 385.7 DEG.C T16REG 388.3 DEG.C T17REG 377.9 DEG.C T18REG 373.3 DEG.C T19REG 228.0 DEG.C T03HED***** DEG.C

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 07/26/84 15:46:40.06 RDG 1008

FLUID HELIUM BAROM 14.303 PSI REGENERATOR 1 DISPLACER 1 STANDARD PISTON

HEAT TO DASHPCT COOLING FLODP 3.94 L/MIN	POWER IN AMPS1 604. AMPS AMPS2 557. AMPS VOLTG 2.53 VOLTS	ENGINE CHARGE PRESSURE PRESUP 7055. KPA MEANBP 6988. KPA MEANCP 7023. KPA	GAS TEMPERATURES TGEXP 562.6 DEG.C TGREGH 563.2 DEG.C TGREGC 94.9 DEG.C TGCOMP 45.4 DEG.C TGBOUN 30.6 DEG.C	SURFACE TEMPERATURES T01HTR 603.8 DEG.C T02HTR 604.7 DEG.C T03HTR 615.3 DEG.C T04HTR 605.1 DEG.C T05HTR 617.5 DEG.C T06HTR 608.2 DEG.C T07HTR 606.3 DEG.C T08HTR 584.0 DEG.C T09HTR 610.7 DEG.C T10HTR 589.5 DEG.C T11HTR 577.5 DEG.C T12HTR 576.1 DEG.C
HEAT TO COOLER FLOCLR 4.23 L/MIN TWINCL 24.7 DEG.C TDLCL 7.61 DEG.C TWOCLR 30.73 DEG.C	CALCULATED PARAMETERS 1 PWRIN 2930. WATTS 2 QCOOLR 2233. WATTS 3 QDSHPT 470. WATTS 4 EXTEFF 24.0 % 5 TAVHTR 599.9 DEG.C 6 INTEFF 23.9 % 8 AMPS 1160. AMPS 9 QDISPG 3. WATTS 10 QDISP 15. WATTS 11 QREG1 117. WATTS 12 QREG2 115. WATTS 13 QREG3 36. WATTS 14 PFP 1025.2 KPA/CM 15 PFD 339.6 KPA/CM 16 NBEALE 0.00589	VIBRATION VX1HOR 0.3 CM/S VY1VER 7.2 CM/S PHASE ANGLES PADISP 56.7 DEG. PAPRES -17.7 DEG. ENGINE SPEED FREQ 30.2 HZ	REMOTE CALCULATIONS FWROUT 703. WATTS INDPWR 753. WATTS PISTST 2.20 CM DISPST 2.09 CM DYNAMIC CALCULATIONS PAMPC 97.9 KPA DISPCP 2.27 CM PISTCP 2.34 CM PDYNDB***** KPA PDLCLR 4.07 KPA PDLREG 47.86 KPA PDLDIS 82.13 KPA	T13REG***** DEG.C T14REG 518.7 DEG.C T15REG 388.8 DEG.C T16REG 389.2 DEG.C T17REG 380.1 DEG.C T18REG 376.6 DEG.C T19REG 232.8 DEG.C T03HED***** DEG.C

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 07/26/84 15:50:22.06 RDG 1009

FLUID HELIUM BAROM 14.303 PSI REGENERATOR 1 DISPLACER 1 STANDARD PISTON

HEAT TO DASHPOT COOLING FLODP 3.97 L/MIN	POWER IN AMPS1 637. AMPS AMPS2 585. AMPS VOLTG 2.66 VOLTS	ENGINE CHARGE PRESSURE PRESUP 7339. KPA MEANBP 6999. KPA MEANCP 7036. KPA	GAS TEMPERATURES TGEXP 561.2 DEG.C TGREGH 558.0 DEG.C TGREGC 94.3 DEG.C TGCOMP 48.5 DEG.C TGBOUN 32.1 DEG.C	SURFACE TEMPERATURES T01HTR 602.1 DEG.C T02HTR 608.6 DEG.C T03HTR 616.2 DEG.C T04HTR 604.3 DEG.C T05HTR 620.1 DEG.C T06HTR 611.6 DEG.C T07HTR 610.2 DEG.C T08HTR 581.4 DEG.C T09HTR 609.4 DEG.C T10HTR 588.8 DEG.C T11HTR 573.6 DEG.C T12HTR 577.0 DEG.C
HEAT TO COOLER FLOCLR 4.23 L/MIN TWINCL 24.7 DEG.C TDLCL 8.53 DEG.C TWOCLR 31.51 DEG.C	CALCULATED PARAMETERS 1 PWRIN 3253. WATTS 2 QCOOLR 2505. WATTS 3 QDSHPT 545. WATTS 4 EXTEFF 24.4 % 5 TAVHTR 600.3 DEG.C 6 INTEFF 24.1 % 8 AMPS 1222. AMPS 9 QDISPG 3. WATTS 10 QDISP 15. WATTS 11 QREG1 108. WATTS 12 QREG2 125. WATTS 13 QREG3 36. WATTS 14 PFP 1012.0 KPA/CM 15 PFD 324.2 KPA/CM 16 NBEALE 0.00609	VIBRATION VX1HOR 0.3 CM/S VY1VER 7.9 CM/S PHASE ANGLES PADISP 57.1 DEG. PAPRES -16.5 DEG. ENGINE SPEED FREQ 30.2 HZ	REMOTE CALCULATIONS FWROUT 794. WATTS INDPWR 856. WATTS PISTST 2.40 CM DISPST 2.22 CM DYNAMIC CALCULATIONS PAMPC 1063. KPA DISPCP 2.37 CM PISTCP 2.38 CM PDYNDB***** KPA PDLCLR 5.43 KPA PDLREG 52.95 KPA PDLDIS 90.28 KPA	T13REG***** DEG.C T14REG 517.8 DEG.C T15REG 384.9 DEG.C T16REG 378.4 DEG.C T17REG 364.0 DEG.C T18REG 364.0 DEG.C T19REG 231.2 DEG.C T03HED***** DEG.C

APPENDIX C. - CONTINUED.

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 07/26/84 15:55:25.06 RDG 1010

FLUID HELIUM		BAROM 14.303 PSI		REGENERATOR 1	DISPLACER 1	STANDARD PISTON	
HEAT TO DASHPOT COOLING		POWER IN		ENGINE CHARGE PRESSURE		GAS TEMPERATURES	SURFACE TEMPERATURES
FLODP 3.96 L/MIN		AMPS1 673. AMPS		PRESUP 7464. KPA		TGEXP 557.5 DEG.C	T01HTR 598.1 DEG.C
		AMPS2 619. AMPS				TGREGH 548.5 DEG.C	T02HTR 610.5 DEG.C
TWINDP 17.8 DEG.C		VOLTG 2.82 VOLTS		MEANBP 6988. KPA		TGREGC 90.7 DEG.C	T03HTR 614.9 DEG.C
TDLDP 2.21 DEG.C				MEANCP 7032. KPA		TGCOMP 55.7 DEG.C	T04HTR 601.4 DEG.C
TWODPR 20.8 DEG.C						TGBOUN 33.4 DEG.C	T05HTR 621.1 DEG.C
							T06HTR 613.0 DEG.C
							T07HTR 611.9 DEG.C
							T08HTR 576.7 DEG.C
							T09HTR 605.4 DEG.C
HEAT TO COOLER		CALCULATED PARAMETERS		VIBRATION		REMOTE CALCULATIONS	T10HTR 586.4 DEG.C
FLOCLR 4.22 L/MIN		1 PWRIN 3643. WATTS		VX1HOR 0.4 CM/S		PWRROUT 866. WATTS	T11HTR 567.1 DEG.C
TWINCL 24.8 DEG.C		2 QCOOLR 2736. WATTS		VY1VER 8.5 CM/S		INDFWR 939. WATTS	T12HTR 576.9 DEG.C
TDLCL 9.34 DEG.C		3 QDSHPT 607. WATTS				PISTST 2.60 CM	
TWOCLR 32.52 DEG.C		4 EXTEFF 23.8 %				DISPST 2.34 CM	
		5 TAVHTR 598.6 DEG.C		PHASE ANGLES		DYNAMIC CALCULATIONS	T13REG***** DEG.C
		6 INTEFF 24.0 %		PADISP 57.5 DEG.		PAMPC 1147. KPA	T14REG 510.3 DEG.C
		8 AMPS 1292. AMPS		PAPRES -15.7 DEG.		DISPCP 2.37 CM	T15REG 368.0 DEG.C
		9 QDISPG 3. WATTS		ENGINE SPEED		PISTCP 2.33 CM	T16REG 350.7 DEG.C
		10 QDISP 14. WATTS		FREQ 30.1 HZ		PDYNDB***** KPA	T17REG 331.5 DEG.C
		11 QREG1 96. WATTS				PDLCLR 6.79 KPA	T18REG 338.9 DEG.C
		12 QREG2 139. WATTS				PDLREG 55.66 KPA	T19REG 221.0 DEG.C
		13 QREG3 35. WATTS				PDLDIS 95.71 KPA	
		14 PFP 1002.8 KPA/CM					T03HED***** DEG.C
		15 PFD 314.1 KPA/CM					
		16 NBEALE 0.00617					

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 07/26/84 16:00:55.09 RDG 1011

FLUID HELIUM		BAROM 14.303 PSI		REGENERATOR 1	DISPLACER 1	STANDARD PISTON	
HEAT TO DASHPOT COOLING		POWER IN		ENGINE CHARGE PRESSURE		GAS TEMPERATURES	SURFACE TEMPERATURES
FLODP 3.93 L/MIN		AMPS1 702. AMPS		PRESUP 7063. KPA		TGEXP 555.5 DEG.C	T01HTR 598.9 DEG.C
		AMPS2 653. AMPS				TGREGH 545.4 DEG.C	T02HTR 612.9 DEG.C
TWINDP 17.8 DEG.C		VOLTG 2.98 VOLTS		MEANBP 6987. KPA		TGREGC 92.1 DEG.C	T03HTR 617.1 DEG.C
TDLDP 2.67 DEG.C				MEANCP 7034. KPA		TGCOMP 61.1 DEG.C	T04HTR 602.4 DEG.C
TWODPR 21.2 DEG.C						TGBOUN 35.8 DEG.C	T05HTR 624.1 DEG.C
							T06HTR 616.0 DEG.C
							T07HTR 614.9 DEG.C
							T08HTR 576.4 DEG.C
HEAT TO COOLER		CALCULATED PARAMETERS		VIBRATION		REMOTE CALCULATIONS	T09HTR 606.9 DEG.C
FLOCLR 4.23 L/MIN		1 PWRIN 4038. WATTS		VX1HOR 0.4 CM/S		PWRROUT 955. WATTS	T10HTR 586.4 DEG.C
TWINCL 24.9 DEG.C		2 QCOOLR 3032. WATTS		VY1VER 9.2 CM/S		INDPWR 1030. WATTS	T11HTR 566.2 DEG.C
TDLCL 10.32 DEG.C		3 QDSHPT 732. WATTS				PISTST 2.80 CM	T12HTR 577.3 DEG.C
TWOCLR 33.65 DEG.C		4 EXTEFF 23.7 %		PHASE ANGLES		DISPST 2.45 CM	
		5 TAVHTR 600.0 DEG.C		PADISP 57.5 LEG.		DYNAMIC CALCULATIONS	T13REG***** DEG.C
		6 INTEFF 24.0 %		PAPRES -15.2 DEG.		PAMPC 1250. KPA	T14REG 506.8 DEG.C
		8 AMPS 1355. AMPS		ENGINE SPEED		DISPCP 2.36 CM	T15REG 359.0 DEG.C
		9 QDISPG 3. WATTS		FREQ 30.1 HZ		PISTCP 2.29 CM	T16REG 339.8 DEG.C
		10 QDISP 14. WATTS				PDYNDB***** KPA	T17REG 317.8 DEG.C
		11 QREG1 90. WATTS				PDLCLR 8.82 KPA	T18REG 326.8 DEG.C
		12 QREG2 146. WATTS				PDLREG 60.41 KPA	T19REG 216.2 DEG.C
		13 QREG3 35. WATTS				PDLDIS 103.52 KPA	
		14 PFP 1010.0 KPA/CM					T03HED***** DEG.C
		15 PFD 317.9 KPA/CM					
		16 NBEALE 0.00631					

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 07/26/84 16:03:22.09 RDG 1012

FLUID HELIUM		BAROM 14.303 PSI		REGENERATOR 1	DISPLACER 1	STANDARD PISTON	
HEAT TO DASHPOT COOLING		POWER IN		ENGINE CHARGE PRESSURE		GAS TEMPERATURES	SURFACE TEMPERATURES
FLODP 3.93 L/MIN		AMPS1 742. AMPS		PRESUP 7066. KPA		TGEXP 552.5 DEG.C	T01HTR 598.1 DEG.C
		AMPS2 683. AMPS				TGREGH 540.3 DEG.C	T02HTR 613.6 DEG.C
TWINDP 17.9 DEG.C		VOLTG 3.13 VOLTS		MEANBP 7000. KPA		TGREGC 92.6 DEG.C	T03HTR 617.4 DEG.C
TDLDP 2.89 DEG.C				MEANCP 7049. KPA		TGCOMP 65.4 DEG.C	T04HTR 601.2 DEG.C
TWODPR 21.4 DEG.C						TGBOUN 37.2 DEG.C	T05HTR 625.1 DEG.C
							T06HTR 616.7 DEG.C
							T07HTR 615.6 DEG.C
							T08HTR 574.6 DEG.C
							T09HTR 606.0 DEG.C
HEAT TO COOLER		CALCULATED PARAMETERS		VIBRATION		REMOTE CALCULATIONS	T10HTR 585.4 DEG.C
FLOCLR 4.24 L/MIN		1 PWRIN 4467. WATTS		VX1HOR 0.4 CM/S		PWRROUT 1026. WATTS	T11HTR 563.2 DEG.C
TWINCL 24.9 DEG.C		2 QCOOLR 3265. WATTS		VY1VER 9.8 CM/S		INDPWR 1100. WATTS	T12HTR 576.1 DEG.C
TDLCL 11.10 DEG.C		3 QDSHPT 791. WATTS				PISTST 3.00 CM	
TWOCLR 34.54 DEG.C		4 EXTEFF 23.0 %		PHASE ANGLES		DISPST 2.51 CM	
		5 TAVHTR 599.4 DEG.C		PADISP 57.6 DEG.		DYNAMIC CALCULATIONS	T13REG***** DEG.C
		6 INTEFF 23.9 %		PAPRES -14.0 DEG.		PAMPC 1344. KPA	T14REG 500.1 DEG.C
		8 AMPS 1426. AMPS		ENGINE SPEED		DISPCP 2.35 CM	T15REG 346.2 DEG.C
		9 QDISPG 3. WATTS		FREQ 30.2 HZ		PISTCP 2.26 CM	T16REG 326.9 DEG.C
		10 QDISP 14. WATTS				PDYNDB***** KPA	T17REG 303.8 DEG.C
		11 QREG1 85. WATTS				PDLCLR 11.20 KPA	T18REG 313.6 DEG.C
		12 QREG2 151. WATTS				PDLREG 63.81 KPA	T19REG 208.9 DEG.C
		13 QREG3 35. WATTS				PDLDIS 109.97 KPA	
		14 PFP 1007.4 KPA/CM					T03HED***** DEG.C
		15 PFD 306.5 KPA/CM					
		16 NBEALE 0.00631					

APPENDIX C. - CONTINUED.

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 07/26/84 16:10:31.09 RDG 1013

FLUID HELIUM		BAROM 14.303 PSI REGENERATOR 1 DISPLACER 1 STANDARD PISTON				SURFACE TEMPERATURES	
HEAT TO DASHPOT COOLING		POWER IN	ENGINE CHARGE PRESSURE	GAS TEMPERATURES			
FLODP 3.91 L/MIN		AMPS1 494. AMPS	PRESUP 7273. KPA	TGEXP 521.6 DEG.C	T01HTR 551.8 DEG.C		
		AMPS2 487. AMPS			T02HTR 556.2 DEG.C		
TWINDP 17.9 DEG.C	VOLTG 2.14 VOLTS		MEANBP 7014. KPA	TGREGH 517.7 DEG.C	T03HTR 562.5 DEG.C		
TDLDP 1.65 DEG.C			MEANCP 7048. KPA	TGREGC 88.2 DEG.C	T04HTR 556.3 DEG.C		
TWODPR 20.2 DEG.C				TGCOMP 43.2 DEG.C	T05HTR 565.1 DEG.C		
				TGBOUN 34.1 DEG.C	T06HTR 557.6 DEG.C		
HEAT TO COOLER		CALCULATED PARAMETERS	VIBRATION	REMOTE CALCULATIONS	T07HTR 555.8 DEG.C		
FLOCRL 4.23 L/MIN	1 PWRIN 2100. WATTS		VX1HOR 0.2 CM/S	PWRROUT 479. WATTS	T08HTR 535.2 DEG.C		
TWINCL 24.8 DEG.C	2 QCOOLR 1978. WATTS		VY1VER 6.0 CM/S	INDPWR 514. WATTS	T09HTR 559.3 DEG.C		
TDLCL 6.73 DEG.C	3 QDSHFT 449. WATTS			PISTST 1.80 CM	T10HTR 543.0 DEG.C		
TWOCLR 29.88 DEG.C	4 EXTEFF 22.8 %		PHASE ANGLES	DISPST 1.81 CM	T11HTR 530.5 DEG.C		
	5 TAVHTR 550.5 DEG.C		PADISP 57.8 DEG.	DYNAMIC CALCULATIONS	T12HTR 532.3 DEG.C		
	6 INTEFF 19.5 %		PAPRES -17.6 DEG.	PAMPC 792. KPA	T13REG***** DEG.C		
	8 AMPS 981. AMPS		ENGINE SPEED	DISPCP 2.16 CM	T14REG 477.8 DEG.C		
	9 QDISPG 3. WATTS		FREQ 30.2 HZ	PISTCP 2.31 CM	T15REG 357.7 DEG.C		
	10 QDISP 14. WATTS			PDYNDB***** KPA	T16REG 359.1 DEG.C		
	11 QREG1 108. WATTS			PDLCLR 3.05 KPA	T17REG 348.7 DEG.C		
	12 QPEG2 107. WATTS			PDLREG 37.33 KPA	T18REG 346.4 DEG.C		
	13 QREG3 33. WATTS			PDLDIS 68.56 KPA	T19REG 213.1 DEG.C		
	14 PFP 1004.7 KPA/CM				T03HED***** DEG.C		
	15 PFD 312.6 KPA/CM						
	16 NBEALE 0.00489						

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 07/26/84 16:15:40.12 RDG 1014

FLUID HELIUM		BAROM 14.303 PSI REGENERATOR 1 DISPLACER 1 STANDARD PISTON				SURFACE TEMPERATURES	
HEAT TO DASHPOT COOLING		POWER IN	ENGINE CHARGE PRESSURE	GAS TEMPERATURES			
FLODP 3.94 L/MIN		AMPS1 537. AMPS	PRESUP 7176. KPA	TGEXP 518.2 DEG.C	T01HTR 553.9 DEG.C		
		AMPS2 518. AMPS			T02HTR 555.2 DEG.C		
TWINDP 17.9 DEG.C	VOLTG 2.30 VOLTS		MEANBP 6998. KPA	TGREGH 517.7 DEG.C	T03HTR 564.7 DEG.C		
TDLDP 1.82 DEG.C			MEANCP 7034. KPA	TGREGC 89.4 DEG.C	T04HTR 556.1 DEG.C		
TWODPR 20.4 DEG.C				TGCOMP 44.9 DEG.C	T05HTR 566.8 DEG.C		
				TGBOUN 34.7 DEG.C	T06HTR 557.4 DEG.C		
HEAT TO COOLER		CALCULATED PARAMETERS	VIBRATION	REMOTE CALCULATIONS	T07HTR 555.6 DEG.C		
FLOCRL 4.22 L/MIN	1 PWRIN 2423. WATTS		VX1HOR 0.3 CM/S	PWRROUT 544. WATTS	T08HTR 536.2 DEG.C		
TWINCL 24.5 DEG.C	2 QCOOLR 2073. WATTS		VY1VER 6.6 CM/S	INDPWR 582. WATTS	T09HTR 560.4 DEG.C		
TDLCL 7.07 DEG.C	3 QDSHFT 498. WATTS			PISTST 1.99 CM	T10HTR 542.4 DEG.C		
TWOCLR 30.05 DEG.C	4 EXTEFF 22.4 %		PHASE ANGLES	DISPST 1.93 CM	T11HTR 530.3 DEG.C		
	5 TAVHTR 550.8 DEG.C		PADISP 58.1 DEG.	DYNAMIC CALCULATIONS	T12HTR 529.9 DEG.C		
	6 INTEFF 20.8 %		PAPRES -16.7 DEG.	PAMPC 871. KPA	T13REG***** DEG.C		
	8 AMPS 1054. AMPS		ENGINE SPEED	DISPCP 2.33 CM	T14REG 476.5 DEG.C		
	9 QDISPG 3. WATTS		FREQ 30.1 HZ	PISTCP 2.31 CM	T15REG 358.2 DEG.C		
	10 QDISP 13. WATTS			PDYNDB***** KPA	T16REG 359.3 DEG.C		
	11 QREG1 109. WATTS			PDLCLR 3.56 KPA	T17REG 351.5 DEG.C		
	12 QPEG2 103. WATTS			PDLREG 42.76 KPA	T18REG 348.9 DEG.C		
	13 QREG3 33. WATTS			PDLDIS 74.33 KPA	T19REG 215.1 DEG.C		
	14 PFP 993.7 KPA/CM				T03HED***** DEG.C		
	15 PFD 305.2 KPA/CM						
	16 NBEALE 0.00505						

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 07/26/84 16:20:22.12 RDG 1015

FLUID HELIUM		BAROM 14.303 PSI REGENERATOR 1 DISPLACER 1 STANDARD PISTON				SURFACE TEMPERATURES	
HEAT TO DASHPOT COOLING		POWER IN	ENGINE CHARGE PRESSURE	GAS TEMPERATURES			
FLODP 4.10 L/MIN		AMPS1 573. AMPS	PRESUP 7276. KPA	TGEXP 515.3 DEG.C	T01HTR 555.3 DEG.C		
		AMPS2 552. AMPS			T02HTR 554.2 DEG.C		
TWINDP 18.0 DEG.C	VOLTG 2.45 VOLTS		MEANBP 6994. KPA	TGREGH 516.9 DEG.C	T03HTR 566.5 DEG.C		
TDLDP 1.87 DEG.C			MEANCP 7035. KPA	TGREGC 91.7 DEG.C	T04HTR 555.3 DEG.C		
TWODPR 20.5 DEG.C				TGCOMP 46.8 DEG.C	T05HTR 562.3 DEG.C		
				TGBOUN 34.8 DEG.C	T06HTR 557.5 DEG.C		
HEAT TO COOLER		CALCULATED PARAMETERS	VIBRATION	REMOTE CALCULATIONS	T07HTR 555.6 DEG.C		
FLOCRL 4.21 L/MIN	1 PWRIN 2761. WATTS		VX1HOR 0.3 CM/S	PWRROUT 627. WATTS	T08HTR 536.4 DEG.C		
TWINCL 24.4 DEG.C	2 QCOOLR 2285. WATTS		VY1VER 7.2 CM/S	INDPWR 673. WATTS	T09HTR 561.0 DEG.C		
TDLCL 7.82 DEG.C	3 QDSHFT 534. WATTS			PISTST 2.20 CM	T10HTR 541.8 DEG.C		
TWOCLR 30.61 DEG.C	4 EXTEFF 22.7 %		PHASE ANGLES	DISPST 2.06 CM	T11HTR 529.2 DEG.C		
	5 TAVHTR 550.7 DEG.C		PADISP 58.1 DEG.	DYNAMIC CALCULATIONS	T12HTR 527.7 DEG.C		
	6 INTEFF 21.5 %		PAPRES -15.9 DEG.	PAMPC 974. KPA	T13REG***** DEG.C		
	8 AMPS 1125. AMPS		ENGINE SPEED	DISPCP 2.26 CM	T14REG 475.3 DEG.C		
	9 QDISPG 3. WATTS		FREQ 30.1 HZ	PISTCP 2.31 CM	T15REG 357.1 DEG.C		
	10 QDISP 13. WATTS			PDYNDB***** KPA	T16REG 358.8 DEG.C		
	11 QREG1 108. WATTS			PDLCLR 4.41 KPA	T17REG 352.5 DEG.C		
	12 QPEG2 102. WATTS			PDLREG 47.86 KPA	T18REG 349.0 DEG.C		
	13 QREG3 33. WATTS			PDLDIS 82.13 KPA	T19REG 215.6 DEG.C		
	14 PFP 1003.4 KPA/CM				T03HED***** DEG.C		
	15 PFD 304.9 KPA/CM						
	16 NBEALE 0.00527						

APPENDIX C. - CONTINUED.

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 07/26/84 16:25:22.12 RDG 1016

FLUID HELIUM		BAROM 14.298 PSI REGENERATOR 1 DISPLACER 1 STANDARD PISTON									
HEAT TO DASHPOT COOLING	FLODP	4.11 L/MIN	POWER IN	ENGINE CHARGE PRESSURE				GAS TEMPERATURES			
			AMPS1	612. AMPS	PRESUP 7122. KPA				TGEXP 511.8 DEG.C	T01HTR	551.1 DEG.C
			AMPS2	577. AMPS					TGREGH 510.2 DEG.C	T02HTR	555.6 DEG.C
			VOLTG	2.59 VOLTS	MEANBP 6992. KPA				TGREGC 92.2 DEG.C	T03HTR	564.6 DEG.C
					MEANCP 7037. KPA				TGCCOMP 49.6 DEG.C	T04HTR	552.4 DEG.C
									TGBOUN 35.4 DEG.C	T05HTR	568.3 DEG.C
									T06HTR 558.7 DEG.C	T06HTR	558.7 DEG.C
									T07HTR 557.3 DEG.C	T07HTR	557.3 DEG.C
									T08HTR 531.3 DEG.C	T08HTR	531.3 DEG.C
									T09HTR 557.6 DEG.C	T09HTR	557.6 DEG.C
HEAT TO COOLER	FLOCLR	4.21 L/MIN	CALCULATED PARAMETERS	VIBRATION				REMOTE CALCULATIONS			
			1 PWURIN	3086. WATTS	VX1HOR 0.4 CM/S				PWRROUT 706. WATTS	T10HTR	538.2 DEG.C
			2 QCOOLR	2470. WATTS	VY1VER 7.9 CM/S				INDPWR 764. WATTS	T11HTR	523.3 DEG.C
			3 QDSHPT	572. WATTS					PISTST 2.41 CM	T12HTR	526.2 DEG.C
			4 EXTEFF	22.9 %	PHASE ANGLES				DISPST 2.20 CM		
			5 TAVHTR	548.7 DEG.C	PADISP 58.4 DEG.				DYNAMIC CALCULATIONS	T13REG***** DEG.C	
			6 INTEFF	22.2 %	PAPRES -14.7 DEG.				PAMPC 1068. KPA	T14REG 473.9 DEG.C	
			8 AMPS	1129. AMPS					DISPCP 2.40 CM	T15REG 355.5 DEG.C	
			9 QDISPG	3. WATTS	ENGINE SPEED				PISTCP 2.38 CM	T16REG 351.6 DEG.C	
			10 QDISP	13. WATTS	FREQ 30.1 HZ				PDYNDB***** KPA	T17REG 340.8 DEG.C	
			11 QREG1	100. WATTS					PDLCLR 5.60 KPA	T18REG 339.3 DEG.C	
			12 QREG2	109. WATTS					PDLREG 52.95 KPA	T19REG 216.2 DEG.C	
			13 QREG3	32. WATTS					PDLDIS 91.98 KPA		
			14 PFP	996.6 KPA/CM					T03HED***** DEG.C		
			15 PFD	289.2 KPA/CM							
			16 NBEALE	0.00542							

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 07/26/84 16:30:25.12 RDG 1017

FLUID HELIUM		BAROM 14.298 PSI REGENERATOR 1 DISPLACER 1 STANDARD PISTON									
HEAT TO DASHPOT COOLING	FLODP	4.08 L/MIN	POWER IN	ENGINE CHARGE PRESSURE				GAS TEMPERATURES			
			AMPS1	645. AMPS	PRESUP 7187. KPA				TGEXP 510.7 DEG.C	T01HTR	550.9 DEG.C
			AMPS2	608. AMPS					TGREGH 507.3 DEG.C	T02HTR	558.5 DEG.C
			VOLTG	2.73 VOLTS	MEANBP 7011. KPA				TGREGC 92.3 DEG.C	T03HTR	565.8 DEG.C
					MEANCP 7062. KPA				TGCCOMP 53.4 DEG.C	T04HTR	553.1 DEG.C
									TGBOUN 36.2 DEG.C	T05HTR	570.6 DEG.C
									T06HTR 561.8 DEG.C	T06HTR	561.8 DEG.C
									T07HTR 560.5 DEG.C	T07HTR	560.5 DEG.C
									T08HTR 530.1 DEG.C	T08HTR	530.1 DEG.C
HEAT TO COOLER	FLOCLR	4.22 L/MIN	CALCULATED PARAMETERS	VIBRATION				REMOTE CALCULATIONS			
			1 PWURIN	3424. WATTS	VX1HOR 0.4 CM/S				PWRROUT 776. WATTS	T09HTR	558.1 DEG.C
			2 QCOOLR	2713. WATTS	VY1VER 0.5 CM/S				INDPWR 846. WATTS	T10HTR	537.8 DEG.C
			3 QDSHPT	651. WATTS					PISTST 2.60 CM	T11HTR	521.5 DEG.C
			4 EXTEFF	22.7 %	PHASE ANGLES				DISPST 2.30 CM	T12HTR	526.8 DEG.C
			5 TAVHTR	549.6 DEG.C	PADISP 58.8 DEG.				DYNAMIC CALCULATIONS	T13REG***** DEG.C	
			6 INTEFF	22.2 %	PAPRES -14.1 DEG.				PAMPC 1166. KPA	T14REG 473.2 DEG.C	
			8 AMPS	1253. AMPS					DISPCP 2.35 CM	T15REG 352.3 DEG.C	
			9 QDISPG	3. WATTS	ENGINE SPEED				PISTCP 2.35 CM	T16REG 343.8 DEG.C	
			10 QDISP	13. WATTS	FREQ 30.2 HZ				PDYNDB***** KPA	T17REG 330.4 DEG.C	
			11 QREG1	93. WATTS					PDLCLR 6.79 KPA	T18REG 330.0 DEG.C	
			12 QREG2	116. WATTS					PDLREG 57.70 KPA	T19REG 215.2 DEG.C	
			13 QREG3	32. WATTS					PDLDIS 98.77 KPA		
			14 PFP	1003.3 KPA/CM					T03HED***** DEG.C		
			15 PFD	289.5 KPA/CM							
			16 NBEALE	0.00549							

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 07/26/84 16:35:25.12 RDG 1018

FLUID HELIUM		BAROM 14.298 PSI REGENERATOR 1 DISPLACER 1 STANDARD PISTON									
HEAT TO DASHPOT COOLING	FLODP	4.06 L/MIN	POWER IN	ENGINE CHARGE PRESSURE				GAS TEMPERATURES			
			AMPS1	695. AMPS	PRESUP 7360. KPA				TGEXP 507.8 DEG.C	T01HTR	548.6 DEG.C
			AMPS2	646. AMPS					TGREGH 498.0 DEG.C	T02HTR	561.7 DEG.C
			VOLTG	2.93 VOLTS	MEANBP 7004. KPA				TGREGC 88.8 DEG.C	T03HTR	566.1 DEG.C
					MEANCP 7057. KPA				TGCCOMP 62.1 DEG.C	T04HTR	551.9 DEG.C
									TGBOUN 37.6 DEG.C	T05HTR	573.0 DEG.C
									T06HTR 564.2 DEG.C	T06HTR	564.2 DEG.C
									T07HTR 563.3 DEG.C	T07HTR	563.3 DEG.C
									T08HTR 526.9 DEG.C	T08HTR	526.9 DEG.C
									T09HTR 555.9 DEG.C	T09HTR	555.9 DEG.C
HEAT TO COOLER	FLOCLR	4.21 L/MIN	CALCULATED PARAMETERS	VIBRATION				REMOTE CALCULATIONS			
			1 PWURIN	3924. WATTS	VX1HOR 0.4 CM/S				PWRROUT 849. WATTS	T10HTR	536.9 DEG.C
			2 QCOOLR	3092. WATTS	VY1VER 9.2 CM/S				INDPWR 917. WATTS	T11HTR	516.2 DEG.C
			3 QDSHPT	707. WATTS					PISTST 2.81 CM	T12HTR	527.6 DEG.C
			4 EXTEFF	21.6 %	PHASE ANGLES				DISPST 2.41 CM		
			5 TAVHTR	549.4 DEG.C	PADISP 58.8 DEG.				DYNAMIC CALCULATIONS	T13REG***** DEG.C	
			6 INTEFF	21.5 %	PAPRES -13.4 DEG.				PAMPC 1255. KPA	T14REG 462.5 DEG.C	
			8 AMPS	1341. AMPS					DISPCP 2.37 CM	T15REG 327.1 DEG.C	
			9 QDISPG	3. WATTS	ENGINE SPEED				PISTCP 2.27 CM	T16REG 310.0 DEG.C	
			10 QDISP	13. WATTS	FREQ 30.1 HZ				PDYNDB***** KPA	T17REG 291.2 DEG.C	
			11 QREG1	81. WATTS					PDLCLR 9.33 KPA	T18REG 299.0 DEG.C	
			12 QREG2	133. WATTS					PDLREG 61.43 KPA	T19REG 199.2 DEG.C	
			13 QREG3	32. WATTS					PDLDIS 105.89 KPA		
			14 PFP	996.2 KPA/CM					T03HED***** DEG.C		
			15 PFD	282.7 KPA/CM							
			16 NBEALE	0.00559							

APPENDIX C. - CONTINUED.

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 07/26/84 16:40:04.12 RDG 1019

FLUID HELIUM BAROM 14.303 PSI REGENERATOR 1 DISPLACER 1 STANDARD PISTON

HEAT TO DASHPOT COOLING FLODP 4.05 L/MIN	POWER IN AMPS1 736. AMPS AMPS2 683. AMPS VOLTG 3.10 VOLTS	ENGINE CHARGE PRESSURE PRESUP 7090. KPA MEANBP 6994. KPA MEANCP 7048. KPA	GAS TEMPERATURES TGEXP 503.9 DEG.C TGREGH 489.9 DEG.C TGREGC 89.2 DEG.C TGCOMP 68.3 DEG.C TGBOUN 38.9 DEG.C	SURFACE TEMPERATURES T01HTR 547.6 DEG.C T02HTR 564.3 DEG.C T03HTR 566.9 DEG.C T04HTR 551.2 DEG.C T05HTR 575.0 DEG.C T06HTR 566.1 DEG.C T07HTR 565.2 DEG.C T08HTR 525.0 DEG.C T09HTR 554.6 DEG.C
HEAT TO COOLER FLOCRL 4.26 L/MIN TWINCL 24.9 DEG.C TDLCL 11.64 DEG.C TWOCLR 34.96 DEG.C	CALCULATED PARAMETERS 1 PWRIN 4402. WATTS 2 QCQOLR 3442. WATTS 3 QDSHPT 781. WATTS 4 EXTEFF 19.6 % 5 TAVHTR 549.4 DEG.C 6 INTEFF 20.1 % 8 AMPS 1419. AMPS 9 QDISPG 3. WATTS 10 QDISP 12. WATTS 11 QREG1 72. WATTS 12 QREG2 142. WATTS 13 QREG3 31. WATTS 14 PFP 979.1 KPA/CM 15 PFD 264.0 KPA/CM 16 NBEALE 0.00536	VIBRATION VX1HOR 0.4 CM/S VY1VER 9.8 CM/S PHASE ANGLES PADISP 58.5 DEG. PAPRES -11.9 DEG. ENGINE SPEED FREQ 30.1 HZ	REMOTE CALCULATIONS PWRROUT 864. WATTS INDPWR 927. WATTS PISTST 2.99 CM DISPST 2.42 CM DYNAMIC CALCULATIONS PAMPC 1323. KPA DISPCP 2.64 CM PISTCP 2.26 CM PDYNDB***** KPA PDLCLR 12.22 KPA PDLREG 62.45 KPA PDLDIS109.97 KPA	T13REG***** DEG.C T14REG 451.1 DEG.C T15REG 305.2 DEG.C T16REG 286.6 DEG.C T17REG 265.2 DEG.C T18REG 275.5 DEG.C T19REG 186.9 DEG.C T03HED***** DEG.C

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 07/27/84 10:37:22.48 RDG 1020

FLUID HELIUM BAROM 14.327 PSI REGENERATOR 1 DISPLACER 1 STANDARD PISTON

HEAT TO DASHPOT COOLING FLODP 4.78 L/MIN	POWER IN AMPS1 522. AMPS AMPS2 485. AMPS VOLTG 2.16 VOLTS	ENGINE CHARGE PRESSURE PRESUP 7382. KPA MEANBP 7010. KPA MEANCP 7045. KPA	GAS TEMPERATURES TGEXP 472.1 DEG.C TGREGH 468.4 DEG.C TGREGC 83.7 DEG.C TGCOMP 40.0 DEG.C TGBOUN 27.2 DEG.C	SURFACE TEMPERATURES T01HTR 501.1 DEG.C T02HTR 506.4 DEG.C T03HTR 512.4 DEG.C T04HTR 506.2 DEG.C T05HTR 514.6 DEG.C T06HTR 506.6 DEG.C T07HTR 505.1 DEG.C T08HTR 484.9 DEG.C T09HTR 507.6 DEG.C
HEAT TO COOLER FLOCRL 4.20 L/MIN TWINCL 25.1 DEG.C TDLCL ***** DEG.C TWOCLR 29.47 DEG.C	CALCULATED PARAMETERS 1 PWRIN 2178. WATTS 2 QCQOLR 1961. WATTS 3 QDSHPT 271. WATTS 4 EXTEFF 20.6 % 5 TAVHTR 499.9 DEG.C 6 INTEFF 18.6 % 8 AMPS 1007. AMPS 9 QDISPG 2. WATTS 10 QDISP 12. WATTS 11 QREG1 97. WATTS 12 QREG2 95. WATTS 13 QREG3 30. WATTS 14 PFP 1022.1 KPA/CM 15 PFD 297.2 KPA/CM 16 NBEALE 0.00460	VIBRATION VX1HOR 0.3 CM/S VY1VER 5.9 CM/S PHASE ANGLES PADISP 59.5 DEG. PAPRES -16.5 DEG. ENGINE SPEED FREQ 30.2 HZ	REMOTE CALCULATIONS PWRROUT 449. WATTS INDPWR 483. WATTS PISTST 1.80 CM DISPST 1.81 CM DYNAMIC CALCULATIONS PAMPC 817. KPA DISPCP 2.15 CM PISTCP 2.26 CM PDYNDB***** KPA PDLCLR 3.39 KPA PDLREG 37.67 KPA PDLDIS 67.20 KPA	T13REG***** DEG.C T14REG 433.2 DEG.C T15REG 326.1 DEG.C T16REG 325.7 DEG.C T17REG 317.1 DEG.C T18REG 315.9 DEG.C T19REG 196.0 DEG.C T03HED***** DEG.C

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 07/27/84 10:42:25.54 RDG 1021

FLUID HELIUM BAROM 14.327 PSI REGENERATOR 1 DISPLACER 1 STANDARD PISTON

HEAT TO DASHPOT COOLING FLODP 4.53 L/MIN	POWER IN AMPS1 549. AMPS AMPS2 515. AMPS VOLTG 2.28 VOLTS	ENGINE CHARGE PRESSURE PRESUP 7585. KPA MEANBP 6991. KPA MEANCP 7030. KPA	GAS TEMPERATURES TGEXP 470.0 DEG.C TGREGH 468.6 DEG.C TGREGC 85.3 DEG.C TGCOMP 42.2 DEG.C TGBOUN 28.3 DEG.C	SURFACE TEMPERATURES T01HTR 503.1 DEG.C T02HTR 506.0 DEG.C T03HTR 514.3 DEG.C T04HTR 506.0 DEG.C T05HTR 516.5 DEG.C T06HTR 507.3 DEG.C T07HTR 506.0 DEG.C T08HTR 485.9 DEG.C T09HTR 509.0 DEG.C
HEAT TO COOLER FLOCRL 4.20 L/MIN TWINCL 25.0 DEG.C TDLCL ***** DEG.C TWOCLR 30.07 DEG.C	CALCULATED PARAMETERS 1 PWRIN 2432. WATTS 2 QCQOLR 2047. WATTS 3 QDSHPT 339. WATTS 4 EXTEFF 21.0 % 5 TAVHTR 500.5 DEG.C 6 INTEFF 20.0 % 8 AMPS 1065. AMPS 9 QDISPG 2. WATTS 10 QDISP 12. WATTS 11 QREG1 97. WATTS 12 QREG2 94. WATTS 13 QREG3 30. WATTS 14 PFP 1006.9 KPA/CM 15 PFD 284.8 KPA/CM 16 NBEALE 0.00471	VIBRATION VX1HOR 0.3 CM/S VY1VER 6.6 CM/S PHASE ANGLES PADISP 59.3 DEG. PAPRES -15.3 DEG. ENGINE SPEED FREQ 30.1 HZ	REMOTE CALCULATIONS PWRROUT 510. WATTS INDPWR 551. WATTS PISTST 2.01 CM DISPST 1.94 CM DYNAMIC CALCULATIONS PAMPC 901. KPA DISPCP 2.22 CM PISTCP 2.26 CM PDYNDB***** KPA PDLCLR 4.07 KPA PDLREG 42.76 KPA PDLDIS 74.67 KPA	T13REG***** DEG.C T14REG 433.3 DEG.C T15REG 327.0 DEG.C T16REG 325.6 DEG.C T17REG 318.4 DEG.C T18REG 317.7 DEG.C T19REG 198.6 DEG.C T03HED***** DEG.C

APPENDIX C. - CONTINUED.

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 07/27/84 10:47:31.54 RDG 1022

FLUID HELIUM		BAROM 14.327 PSI REGENERATOR 1 DISPLACER 1 STANDARD PISTON				
HEAT TO DASHPOT COOLING		POWER IN		ENGINE CHARGE PRESSURE		GAS TEMPERATURES
FLODP	4.51 L/MIN	AMPS1	581. AMPS	PRESUP	7245. KPA	TGEXP 467.9 DEG.C
		AMPS2	547. AMPS			T01HTR 504.6 DEG.C
TWINDP	16.3 DEG.C	VOLTG	2.42 VOLTS	MEANBP	7015. KPA	T02HTR 505.8 DEG.C
TDLDP	1.27 DEG.C			MEANCP	7055. KPA	T03HTR 516.3 DEG.C
TWODPR	18.2 DEG.C					T04HTR 505.6 DEG.C
						T05HTR 518.7 DEG.C
						T06HTR 508.3 DEG.C
						T07HTR 506.9 DEG.C
						T08HTR 486.3 DEG.C
						T09HTR 510.1 DEG.C
HEAT TO COOLER		CALCULATED PARAMETERS		VIBRATION		REMOTE CALCULATIONS
FLOCLR	4.20 L/MIN	1 PWIRIN	2730. WATTS	VX1HOR	0.4 CM/S	PWRROUT 583. WATTS
TWINCL	24.8 DEG.C	2 QCOOLR	2216. WATTS	VY1VER	7.3 CM/S	INDFWR 630. WATTS
TDLCL	***** DEG.C	3 QDSHPT	398. WATTS			PISTST 2.20 CM
TWOCLR	30.71 DEG.C	4 EXTEFF	21.3 %	PHASE ANGLES		DISPST 2.07 CM
		5 TAVHTR	501.1 DEG.C	PADISP	59.8 DEG.	
		6 INTEFF	20.8 %	PAPRES	-14.5 DEG.	
		8 AMPS	1128. AMPS			DYNAMIC CALCULATIONS
		9 QDISPG	2. WATTS	ENGINE SPEED		PAMPC 994. KPA
		10 QDISP	12. WATTS	FREQ	30.2 HZ	DISPCP 2.24 CM
		11 QREG1	95. WATTS			PISTCP 2.29 CM
		12 QPEG2	93. WATTS			PDYNDB***** KPA
		13 QREG3	29. WATTS			PDLCLR 4.58 KPA
		14 PFP	1007.7 KPA/CM			PDLREG 47.86 KPA
		15 PFD	278.8 KPA/CM			PDLDIS 83.15 KPA
		16 NBEALE	0.00488			T03HED***** DEG.C

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 07/27/84 10:52:22.54 RDG 1023

FLUID HELIUM		BAROM 14.327 PSI REGENERATOR 1 DISPLACER 1 STANDARD PISTON				
HEAT TO DASHPOT COOLING		POWER IN		ENGINE CHARGE PRESSURE		GAS TEMPERATURES
FLODP	4.49 L/MIN	AMPS1	618. AMPS	PRESUP	7584. KPA	TGEXP 465.3 DEG.C
		AMPS2	576. AMPS			T01HTR 504.1 DEG.C
TWINDP	16.2 DEG.C	VOLTG	2.56 VOLTS	MEANBP	7014. KPA	T02HTR 505.9 DEG.C
TDLDP	1.53 DEG.C			MEANCP	7061. KPA	T03HTR 516.7 DEG.C
TWODPR	18.3 DEG.C					T04HTR 504.4 DEG.C
						T05HTR 519.7 DEG.C
						T06HTR 509.5 DEG.C
						T07HTR 508.0 DEG.C
						T08HTR 484.7 DEG.C
						T09HTR 509.9 DEG.C
HEAT TO COOLER		CALCULATED PARAMETERS		VIBRATION		REMOTE CALCULATIONS
FLOCLR	4.20 L/MIN	1 PWIRIN	3062. WATTS	VX1HOR	0.4 CM/S	PWRROUT 658. WATTS
TWINCL	24.8 DEG.C	2 QCOOLR	2456. WATTS	VY1VER	8.0 CM/S	INDPWR 712. WATTS
TDLCL	***** DEG.C	3 QDSHPT	478. WATTS			PISTST 2.41 CM
TWOCLR	31.45 DEG.C	4 EXTEFF	21.5 %	PHASE ANGLES		DISPST 2.21 CM
		5 TAVHIR	500.6 DEG.C	PADISP	60.1 DEG.	
		6 INTEFF	21.1 %	PAPRES	-13.6 DEG.	
		8 AMPS	1194. AMPS			DYNAMIC CALCULATIONS
		9 QDISPG	2. WATTS	ENGINE SPEED		PAMPC 1093. KPA
		10 QDISP	12. WATTS	FREQ	30.2 HZ	DISPCP 2.27 CM
		11 QREG1	93. WATTS			PISTCP 2.27 CM
		12 QPEG2	93. WATTS			PDYNDB***** KPA
		13 QREG3	29. WATTS			PDLCLR 5.60 KPA
		14 PFP	1005.0 KPA/CM			PDLREG 54.30 KPA
		15 PFD	268.6 KPA/CM			PDLDIS 93.00 KPA
		16 NBEALE	0.00502			T03HED***** DEG.C

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 07/27/84 10:57:22.54 RDG 1024

FLUID HELIUM		BAROM 14.327 PSI REGENERATOR 1 DISPLACER 1 STANDARD PISTON				
HEAT TO DASHPOT COOLING		POWER IN		ENGINE CHARGE PRESSURE		GAS TEMPERATURES
FLODP	4.47 L/MIN	AMPS1	646. AMPS	PRESUP	7572. KPA	TGEXP 462.4 DEG.C
		AMPS2	602. AMPS			T01HTR 501.0 DEG.C
TWINDP	16.2 DEG.C	VOLTG	2.68 VOLTS	MEANBP	7000. KPA	T02HTR 507.9 DEG.C
TDLDP	1.71 DEG.C			MEANCP	7048. KPA	T03HTR 515.5 DEG.C
TWODPR	18.6 DEG.C					T04HTR 503.0 DEG.C
						T05HTR 519.9 DEG.C
						T06HTR 511.0 DEG.C
						T07HTR 510.1 DEG.C
						T08HTR 481.0 DEG.C
						T09HTR 507.7 DEG.C
HEAT TO COOLER		CALCULATED PARAMETERS		VIBRATION		REMOTE CALCULATIONS
FLOCLR	4.21 L/MIN	1 PWIRIN	3348. WATTS	VX1HOR	0.4 CM/S	PWRROUT 707. WATTS
TWINCL	24.7 DEG.C	2 QCOOLR	2681. WATTS	VY1VER	8.6 CM/S	INDPWR 765. WATTS
TDLCL	***** DEG.C	3 QDSHPT	531. WATTS			PISTST 2.60 CM
TWOCLR	32.15 DEG.C	4 EXTEFF	21.1 %	PHASE ANGLES		DISPST 2.30 CM
		5 TAVHTR	499.5 DEG.C	PADISP	60.4 DEG.	
		6 INTEFF	20.9 %	PAPRES	-12.5 DEG.	
		8 AMPS	1248. AMPS			DYNAMIC CALCULATIONS
		9 QDISPG	2. WATTS	ENGINE SPEED		PAMPC 1176. KPA
		10 QDISP	12. WATTS	FREQ	30.2 HZ	DISPCP 2.32 CM
		11 QREG1	85. WATTS			PISTCP 2.28 CM
		12 QPEG2	100. WATTS			PDYNDB***** KPA
		13 QREG3	29. WATTS			PDLCLR 6.96 KPA
		14 PFP	995.1 KPA/CM			PDLREG 58.04 KPA
		15 PFD	254.7 KPA/CM			PDLDIS 99.10 KPA
		16 NBEALE	0.00501			T03HED***** DEG.C

APPENDIX C. - CONTINUED.

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 07/27/84 11:02:49.54 RDG 1025

FLUID HELIUM BAROM 14.327 PSI REGENERATOR 1 DISPLACER 1 STANDARD PISTON

HEAT TO DASHPOT COOLING		POWER IN	ENGINE CHARGE PRESSURE	GAS TEMPERATURES	SURFACE TEMPERATURES
FLODP	4.46 L/MIN	AMPS1 686. AMPS	PRESUP 756. KPA	TGEXP 460.4 DEG.C	T01HTR 498.6 DEG.C
		AMPS2 636. AMPS			T02HTR 510.9 DEG.C
TWINDP	16.1 DEG.C	VOLTG 2.85 VOLTS	MEANBP 6987. KPA	TGREGH 453.1 DEG.C	T03HTR 515.5 DEG.C
TDLDP	2.01 DEG.C		MEANCP 7037. KPA	TGREGC 87.7 DEG.C	T04HTR 501.4 DEG.C
TWODPR	18.7 DEG.C			TGCOMP 59.7 DEG.C	T05HTR 522.1 DEG.C
				TGBOUN 33.4 DEG.C	T06HTR 513.0 DEG.C
					T07HTR 512.4 DEG.C
					T08HTR 477.6 DEG.C
					T09HTR 505.3 DEG.C
HEAT TO COOLER		CALCULATED PARAMETERS	VIBRATION	REMOTE CALCULATIONS	
FLOCLR	4.20 L/MIN	1 PWRIN 3764. WATTS	VX1HOR 0.4 CM/S	PWRROUT 767. WATTS	T10HTR 487.3 DEG.C
TWINCL	24.7 DEG.C	2 QCOCLR 2994. WATTS	VY1VER 9.2 CM/S	INDPWR 827. WATTS	T11HTR 466.9 DEG.C
TDLCL	***** DEG.C	3 QDSHPT 623. WATTS		PISTST 2.80 CM	T12HTR 478.1 DEG.C
TWOCLR	33.24 DEG.C	4 EXTEFF 20.4 %	PHASE ANGLES	DISPST 2.41 CM	
		5 TAVHTR 499.1 DEG.C	PADISP 60.8 DEG.		T13REG***** DEG.C
		6 INTEFF 20.4 %	PAPRES -11.8 DEG.	DYNAMIC CALCULATIONS	T14REG 423.8 DEG.C
		8 AMPS 1322. AMPS		PAMPC 1265. KPA	T15REG 306.7 DEG.C
		9 QDISPG 2. WATTS	ENGINE SPEED	DISPCP 2.36 CM	T16REG 290.7 DEG.C
		10 QDISP 11. WATTS	FREQ 30.2 HZ	PISTCP 2.26 CM	T17REG 277.3 DEG.C
		11 QREG1 75. WATTS		PDYNDB***** KPA	T18REG 282.5 DEG.C
		12 QREG2 115. WATTS		PDLCLR 9.33 KPA	T19REG 189.9 DEG.C
		13 QREG3 28. WATTS		PDLREG 61.77 KPA	
		14 PFP 987.7 KPA/CM		PDLDIS 106.23 KPA	
		15 PFD 245.8 KPA/CM			T03HED***** DEG.C
		16 NBEALE 0.00506			

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 07/27/84 11:13:22.54 RDG 1026

FLUID HELIUM BAROM 14.332 PSI REGENERATOR 1 DISPLACER 1 STANDARD PISTON

HEAT TO DASHPOT COOLING		POWER IN	ENGINE CHARGE PRESSURE	GAS TEMPERATURES	SURFACE TEMPERATURES
FLODP	4.24 L/MIN	AMPS1 482. AMPS	PRESUP 7565. KPA	TGEXP 425.8 DEG.C	T01HTR 451.6 DEG.C
		AMPS2 481. AMPS			T02HTR 457.0 DEG.C
TWINDP	16.0 DEG.C	VOLTG 2.06 VOLTS	MEANBP 7011. KPA	TGREGH 421.4 DEG.C	T03HTR 462.9 DEG.C
TDLDP	1.29 DEG.C		MEANCP 7050. KPA	TGREGC 79.6 DEG.C	T04HTR 456.2 DEG.C
TWODPR	18.0 DEG.C			TGCOMP 41.8 DEG.C	T05HTR 465.8 DEG.C
				TGBOUN 31.8 DEG.C	T06HTR 457.1 DEG.C
HEAT TO COOLER		CALCULATED PARAMETERS	VIBRATION	REMOTE CALCULATIONS	T07HTR 455.9 DEG.C
FLOCLR	4.20 L/MIN	1 PWRIN 1983. WATTS	VX1HOR 0.3 CM/S	PWRROUT 396. WATTS	T08HTR 436.2 DEG.C
TWINCL	24.4 DEG.C	2 QCOCLR 2012. WATTS	VY1VER 6.0 CM/S	INDPWR 426. WATTS	T09HTR 457.9 DEG.C
TDLCL	6.90 DEG.C	3 QDSHPT 380. WATTS		PISTST 1.82 CM	T10HTR 444.7 DEG.C
TWOCLR	29.24 DEG.C	4 EXTEFF 20.0 %	PHASE ANGLES	DISPST 1.80 CM	T11HTR 430.2 DEG.C
		5 TAVHTR 450.9 DEG.C	PADISP 61.3 DEG.		T12HTR 434.7 DEG.C
		6 INTEFF 16.5 %	PAPRES -14.4 DEG.	DYNAMIC CALCULATIONS	T13REG***** DEG.C
		8 AMPS 964. AMPS		PAMPC 807. KPA	T14REG 391.1 DEG.C
		9 QDISPG 2. WATTS	ENGINE SPEED	DISPCP 2.19 CM	T15REG 295.0 DEG.C
		10 QDISP 11. WATTS	FREQ 30.1 HZ	PISTCP 2.29 CM	T16REG 294.0 DEG.C
		11 QREG1 87. WATTS		PDYNDB***** KPA	T17REG 286.6 DEG.C
		12 QREG2 85. WATTS		PDLCLR 3.56 KPA	T18REG 286.7 DEG.C
		13 QREG3 26. WATTS		PDLREG 39.71 KPA	T19REG 179.3 DEG.C
		14 PFP 981.6 KPA/CM		PDLDIS 70.93 KPA	
		15 PFD 255.1 KPA/CM			T03HED***** DEG.C
		16 NBEALE 0.00403			

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 07/27/84 11:18:28.54 RDG 1027

FLUID HELIUM BAROM 14.332 PSI REGENERATOR 1 DISPLACER 1 STANDARD PISTON

HEAT TO DASHPOT COOLING		POWER IN	ENGINE CHARGE PRESSURE	GAS TEMPERATURES	SURFACE TEMPERATURES
FLODP	4.16 L/MIN	AMPS1 516. AMPS	PRESUP 7195. KPA	TGEXP 423.6 DEG.C	T01HTR 452.5 DEG.C
		AMPS2 507. AMPS			T02HTR 456.6 DEG.C
TWINDP	16.1 DEG.C	VOLTG 2.18 VOLTS	MEANBP 7001. KPA	TGREGH 420.7 DEG.C	T03HTR 464.1 DEG.C
TDLDP	1.34 DEG.C		MEANCP 7045. KPA	TGREGC 80.6 DEG.C	T04HTR 455.8 DEG.C
TWODPR	18.1 DEG.C			TGCOMP 43.0 DEG.C	T05HTR 467.0 DEG.C
				TGBOUN 31.8 DEG.C	T06HTR 457.5 DEG.C
HEAT TO COOLER		CALCULATED PARAMETERS	VIBRATION	REMOTE CALCULATIONS	T07HTR 456.3 DEG.C
FLOCLR	7.12 L/MIN	1 PWRIN 2233. WATTS	VX1HOR 0.3 CM/S	PWRROUT 444. WATTS	T08HTR 436.2 DEG.C
TWINCL	24.2 DEG.C	2 QCOCLR 2064. WATTS	VY1VER 6.6 CM/S	INDPWR 474. WATTS	T09HTR 458.4 DEG.C
TDLCL	7.10 DEG.C	3 QDSHPT 387. WATTS		PISTST 2.00 CM	T10HTR 444.0 DEG.C
TWOCLR	29.47 DEG.C	4 EXTEFF 19.9 %	PHASE ANGLES	DISPST 1.91 CM	T11HTR 429.2 DEG.C
		5 TAVHTR 450.9 DEG.C	PADISP 60.8 DEG.		T12HTR 433.1 DEG.C
		6 INTEFF 17.7 %	PAPRES -13.1 DEG.	DYNAMIC CALCULATIONS	T13REG***** DEG.C
		8 AMFS 1022. AMPS		PAMPC 891. KPA	T14REG 390.5 DEG.C
		9 QDISPG 2. WATTS	ENGINE SPEED	DISPCP 2.20 CM	T15REG 295.4 DEG.C
		10 QDISP 11. WATTS	FREQ 30.1 HZ	PISTCP 2.26 CM	T16REG 293.0 DEG.C
		11 QREG1 86. WATTS		PDYNDB***** KPA	T17REG 286.8 DEG.C
		12 QREG2 83. WATTS		PDLCLR 4.07 KPA	T18REG 287.6 DEG.C
		13 QREG3 26. WATTS		PDLREG 45.48 KPA	T19REG 181.0 DEG.C
		14 PFP 979.5 KPA/CM		PDLDIS 75.35 KPA	
		15 PFD 242.6 KPA/CM			T03HED***** DEG.C
		16 NBEALE 0.00410			

APPENDIX C. - CONTINUED.

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 07/27/84 11:23:22.54 RDG 1028

FLUID HELIUM BAROM 14.332 PSI REGENERATOR 1 DISPLACER 1 STANDARD PISTON

HEAT TO DASHPOT COOLING	POWER IN	ENGINE CHARGE PRESSURE	GAS TEMPERATURES	SURFACE TEMPERATURES
FLODP 4.11 L/MIN	AMPS1 554. AMPS AMPS2 537. AMPS	PRESUP 7567. KPA	TGEXP 421.0 DEG.C	T01HTR 453.0 DEG.C
TWINDP 16.0 DEG.C	VOLTG 2.33 VOLTS	MEANBP 6994. KPA	TGREGH 419.4 DEG.C	T02HTR 456.5 DEG.C
TDLDP 1.49 DEG.C		MEANCP 7040. KPA	TGREGC 83.4 DEG.C	T03HTR 465.3 DEG.C
TWODPR 18.2 DEG.C			TGCOMP 45.7 DEG.C	T04HTR 455.2 DEG.C
			TGBOUN 31.6 DEG.C	T05HTR 468.5 DEG.C
				T06HTR 458.2 DEG.C
				T07HTR 457.1 DEG.C
				T08HTR 435.6 DEG.C
				T09HTR 458.6 DEG.C
HEAT TO COOLER	CALCULATED PARAMETERS	VIBRATION	REMOTE CALCULATIONS	T10HTR 443.1 DEG.C
FLOCRL 4.24 L/MIN	1 PWIRN 2544. WATTS 2 QCQCLR 2129. WATTS 3 QDSHPT 428. WATTS 4 EXTEFF 19.8 % 5 TAVHTR 450.8 DEG.C 6 INTEFF 19.1 % 8 AMPS 1091. AMPS 9 QDISPG 2. WATTS 10 QDISP 11. WATTS 11 QREG1 84. WATTS 12 QREG2 83. WATTS 13 QPEG3 26. WATTS 14 PFP 986.2 KPA/CM 15 PFD 234.4 KPA/CM 16 NBEALE 0.00423	VXIHOR 0.3 CM/S VYIVER 7.3 CM/S PHASE ANGLES PADISP 61.5 DEG. PAPRES -12.2 DEG.	PWRROUT 503. WATTS INDPWR 536. WATTS PISTST 2.20 CM DISPST 2.04 CM	T11HTR 427.7 DEG.C T12HTR 431.3 DEG.C
TWINCL 25.4 DEG.C		ENGINE SPEED	DYNAMIC CALCULATIONS	T13REG***** DEG.C
TDLCL 7.24 DEG.C		FREQ 30.1 HZ	PAMPC 994. KPA DISPCP 2.21 CM PISTCP 2.26 CM	T14REG 390.4 DEG.C T15REG 297.0 DEG.C
TWOCRL 31.11 DEG.C			PDYNDB***** KPA PDLCLR 4.75 KPA PDLREG 47.52 KPA PDLDIS 83.83 KPA	T16REG 293.1 DEG.C T17REG 287.3 DEG.C T18REG 288.6 DEG.C T19REG 184.4 DEG.C
				T03HED***** DEG.C

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 07/27/84 11:29:31.54 RDG 1029

FLUID HELIUM BAROM 14.332 PSI REGENERATOR 1 DISPLACER 1 STANDARD PISTON

HEAT TO DASHPOT COOLING	POWER IN	ENGINE CHARGE PRESSURE	GAS TEMPERATURES	SURFACE TEMPERATURES
FLODP 4.05 L/MIN	AMPS1 594. AMPS AMPS2 565. AMPS	PRESUP 7241. KPA	TGEXP 418.4 DEG.C	T01HTR 453.2 DEG.C
TWINDP 16.0 DEG.C	VOLTG 2.48 VOLTS	MEANBP 7009. KPA	TGREGH 418.1 DEG.C	T02HTR 456.4 DEG.C
TDLDP 1.78 DEG.C		MEANCP 7049. KPA	TGREGC 85.9 DEG.C	T03HTR 466.4 DEG.C
TWODPR 18.4 DEG.C			TGCOMP 48.6 DEG.C	T04HTR 454.4 DEG.C
			TGBOUN 32.5 DEG.C	T05HTR 469.6 DEG.C
				T06HTR 458.9 DEG.C
				T07HTR 457.8 DEG.C
				T08HTR 434.7 DEG.C
				T09HTR 459.1 DEG.C
HEAT TO COOLER	CALCULATED PARAMETERS	VIBRATION	REMOTE CALCULATIONS	T10HTR 441.8 DEG.C
FLOCRL 4.22 L/MIN	1 PWIRN 2871. WATTS 2 QCQCLR 2392. WATTS 3 QDSHPT 501. WATTS 4 EXTEFF 19.7 % 5 TAVHTR 450.7 DEG.C 6 INTEFF 19.1 % 8 AMPS 1159. AMPS 9 QDISPG 2. WATTS 10 QDISP 11. WATTS 11 QREG1 83. WATTS 12 QREG2 82. WATTS 13 QPEG3 26. WATTS 14 PFP 975.0 KPA/CM 15 PFD 223.1 KPA/CM 16 NBEALE 0.00432	VXIHOR 0.4 CM/S VYIVER 8.0 CM/S PHASE ANGLES PADISP 61.8 DEG. PAPRES -11.3 DEG.	PWRROUT 566. WATTS INDPWR 600. WATTS PISTST 2.41 CM DISPST 2.17 CM	T11HTR 426.2 DEG.C T12HTR 429.3 DEG.C
TWINCL 24.5 DEG.C		ENGINE SPEED	DYNAMIC CALCULATIONS	T13REG***** DEG.C
TDLCL 8.17 DEG.C		FREQ 30.2 HZ	PAMPC 1083. KPA DISPCP 2.24 CM PISTCP 2.27 CM	T14REG 390.4 DEG.C T15REG 298.9 DEG.C
TWOCRL 31.28 DEG.C			PDYNDB***** KPA PDLCLR 5.60 KPA PDLREG 53.96 KPA PDLDIS 94.35 KPA	T16REG 294.0 DEG.C T17REG 288.5 DEG.C T18REG 289.7 DEG.C T19REG 187.8 DEG.C
				T03HED***** DEG.C

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 07/27/84 11:35:10.54 RDG 1030

FLUID HELIUM BAROM 14.332 PSI REGENERATOR 1 DISPLACER 1 STANDARD PISTON

HEAT TO DASHPOT COOLING	POWER IN	ENGINE CHARGE PRESSURE	GAS TEMPERATURES	SURFACE TEMPERATURES
FLODP 4.11 L/MIN	AMPS1 626. AMPS AMPS2 589. AMPS	PRESUP 7562. KPA	TGEXP 415.3 DEG.C	T01HTR 452.3 DEG.C
TWINDP 16.0 DEG.C	VOLTG 2.60 VOLTS	MEANBP 7007. KPA	TGREGH 415.9 DEG.C	T02HTR 456.8 DEG.C
TDLDP 1.90 DEG.C		MEANCP 7061. KPA	TGREGC 88.9 DEG.C	T03HTR 465.5 DEG.C
TWODPR 18.6 DEG.C			TGCOMP 54.6 DEG.C	T04HTR 453.6 DEG.C
			TGBOUN 33.1 DEG.C	T05HTR 469.0 DEG.C
				T06HTR 459.9 DEG.C
				T07HTR 458.8 DEG.C
				T08HTR 432.9 DEG.C
				T09HTR 458.6 DEG.C
HEAT TO COOLER	CALCULATED PARAMETERS	VIBRATION	REMOTE CALCULATIONS	T10HTR 439.4 DEG.C
FLOCRL 4.21 L/MIN	1 PWIRN 3159. WATTS 2 QCQCLR 2595. WATTS 3 QDSHPT 542. WATTS 4 EXTEFF 19.2 % 5 TAVHTR 449.8 DEG.C 6 INTEFF 18.9 % 8 AMPS 1215. AMPS 9 QDISPG 2. WATTS 10 QDISP 10. WATTS 11 QREG1 79. WATTS 12 QREG2 83. WATTS 13 QPEG3 25. WATTS 14 PFP 980.6 KPA/CM 15 PFD 212.3 KPA/CM 16 NBEALE 0.00428	VXIHOR 0.4 CM/S VYIVER 8.6 CM/S PHASE ANGLES PADISP 61.8 DEG. PAPRES -10.3 DEG.	PWRROUT 605. WATTS INDPWR 643. WATTS PISTST 2.60 CM DISPST 2.26 CM	T11HTR 424.0 DEG.C T12HTR 426.7 DEG.C
TWINCL 24.3 DEG.C		ENGINE SPEED	DYNAMIC CALCULATIONS	T13REG***** DEG.C
TDLCL 8.88 DEG.C		FREQ 30.2 HZ	PAMPC 1181. KPA DISPCP 2.30 CM PISTCP 2.25 CM	T14REG 389.2 DEG.C T15REG 299.6 DEG.C
TWOCRL 31.77 DEG.C			PDYNDB***** KPA PDLCLR 6.79 KPA PDLREG 58.38 KPA PDLDIS 100.49 KPA	T16REG 294.9 DEG.C T17REG 288.2 DEG.C T18REG 286.8 DEG.C T19REG 190.0 DEG.C
				T03HED***** DEG.C

APPENDIX C. - CONTINUED.

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 07/27/84 11:40:31.54 RDG 1031

FLUID HELIUM BAROM 14.337 PSI REGENERATOR 1 DISPLACER 1 STANDARD PISTON

HEAT TO DASHPOT COOLING	POWER IN	ENGINE CHARGE PRESSURE	GAS TEMPERATURES	SURFACE TEMPERATURES
FLODP 4.11 L/MIN	AMPS1 664. AMPS	PRESUP 7552. KPA	TGEXP 413.6 DEG.C	T01HTR 449.7 DEG.C
	AMPS2 617. AMPS		T02HTR 459.5 DEG.C	
TWINDP 16.1 DEG.C	VOLTG 2.74 VOLTS	MEANBP 6987. KPA	T03HTR 464.8 DEG.C	
TDLDP 2.10 DEG.C		MEANC 7045. KPA	T04HTR 452.0 DEG.C	
TWODPR 18.9 DEG.C			T05HTR 470.5 DEG.C	
			T06HTR 461.8 DEG.C	
			T07HTR 461.1 DEG.C	
			T08HTR 429.5 DEG.C	
			T09HTR 456.1 DEG.C	
HEAT TO COOLER	CALCULATED PARAMETERS	VIBRATION	REMOTE CALCULATIONS	T10HTR 438.0 DEG.C
FLOC LR 4.21 L/MIN	1 PWRIN 3509. WATTS	VX1HOR 0.4 CM/S	PWRROUT 670. WATTS	T11HTR 419.2 DEG.C
TWINCL 24.3 DEG.C	2 QCOOLR 2859. WATTS	VY1VER 9.2 CM/S	INDPWR 687. WATTS	T12HTR 428.0 DEG.C
TDLCL 9.79 DEG.C	3 QDSHPT 601. WATTS		PISTST 2.80 CM	
TWOCLR 32.66 DEG.C	4 EXTEFF 19.1 %	PHASE ANGLES	DISPST 2.39 CM	
	5 TAVHTR 449.2 DEG.C	PADISP 61.9 DEG.	DYNAMIC CALCULATIONS	T13REG***** DEG.C
	6 INTEFF 19.0 %	PAPRES -9.8 DEG.	PAMPC 1275. KPA	T14REG 384.5 DEG.C
	8 AMPS 1281. AMPS		DISPCP 2.35 CM	T15REG 286.4 DEG.C
	9 QDISPG 2. WATTS	ENGINE SPEED	PISTCP 2.22 CM	T16REG 274.9 DEG.C
	10 QDISP 10. WATTS	FREQ 30.2 HZ	PDYNDB***** KPA	T17REG 265.6 DEG.C
	11 QREG1 70. WATTS		PDLCLR 9.16 KPA	T18REG 267.3 DEG.C
	12 QREG2 95. WATTS		PDLREG 63.13 KPA	T19REG 181.0 DEG.C
	13 QREG3 25. WATTS		PDLDIS 108.27 KPA	T03HED***** DEG.C
	14 PFP 978.5 KPA/CM			
	15 PFD 205.0 KPA/CM			
	16 NBEALE 0.00441			

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 07.27/84 11:43:10.54 RDG 1032

FLUID HELIUM BAROM 14.337 PSI REGENERATOR 1 DISPLACER 1 STANDARD PISTON

HEAT TO DASHPOT COOLING	POWER IN	ENGINE CHARGE PRESSURE	GAS TEMPERATURES	SURFACE TEMPERATURES
FLODP 4.12 L/MIN	AMPS1 724. AMPS	PRESUP 7237. KPA	TGEXP 411.8 DEG.C	T01HTR 447.8 DEG.C
	AMPS2 663. AMPS		T02HTR 464.2 DEG.C	
TWINDP 16.0 DEG.C	VOLTG 2.97 VOLTS	MEANBP 6955. KPA	T03HTR 465.5 DEG.C	
TDLDP 2.20 DEG.C		MEANC 7054. KPA	T04HTR 452.3 DEG.C	
TWODPR 18.9 DEG.C			T05HTR 473.3 DEG.C	
			T06HTR 464.8 DEG.C	
			T07HTR 463.9 DEG.C	
			T08HTR 426.4 DEG.C	
			T09HTR 454.4 DEG.C	
HEAT TO COOLER	CALCULATED PARAMETERS	VIBRATION	REMOTE CALCULATIONS	T10HTR 438.6 DEG.C
FLOC LR 4.21 L/MIN	1 PWRIN 4116. WATTS	VX1HOR 0.5 CM/S	PWRROUT 688. WATTS	T11HTR 414.1 DEG.C
TWINCL 24.3 DEG.C	2 QCOOLR 3252. WATTS	VY1VER 9.8 CM/S	INDPWR 692. WATTS	T12HTR 430.1 DEG.C
TDLCL 11.13 DEG.C	3 QDSHPT 632. WATTS		PISTST 2.98 CM	
TWOCLR 34.14 DEG.C	4 EXTEFF 16.7 %	PHASE ANGLES	DISPST 2.40 CM	
	5 TAVHTR 449.6 DEG.C	PADISP 61.6 DEG.	DYNAMIC CALCULATIONS	T13REG***** DEG.C
	6 INTEFF 17.5 %	PAPRES -8.4 DEG.	PAMPC 1344. KPA	T14REG 368.1 DEG.C
	8 AMPS 1387. AMPS		DISPCP 2.46 CM	T15REG 251.0 DEG.C
	9 QDISPG 2. WATTS	ENGINE SPEED	PISTCP 2.15 CM	T16REG 236.0 DEG.C
	10 QDISP 10. WATTS	FREQ 30.1 HZ	PDYNDB***** KPA	T17REG 222.4 DEG.C
	11 QREG1 57. WATTS		PDLCLR 14.42 KPA	T18REG 230.0 DEG.C
	12 QREG2 112. WATTS		PDLREG 67.20 KPA	T19REG 159.6 DEG.C
	13 QREG3 24. WATTS		PDLDIS 116.41 KPA	T03HED***** DEG.C
	14 PFP 961.9 KPA/CM			
	15 PFD 185.2 KPA/CM			
	16 NBEALE 0.00426			

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 08/03/84 14:38:38.30 RDG 1066

FLUID HELIUM BAROM 14.342 PSI REGENERATOR 1 DISPLACER 1 STANDARD PISTON

HEAT TO DASHPOT COOLING	POWER IN	ENGINE CHARGE PRESSURE	GAS TEMPERATURES	SURFACE TEMPERATURES
FLODP 4.21 L/MIN	AMPS1 512. AMPS	PRESUP 5570. KPA	TGEXP 566.1 DEG.C	T01HTR 598.8 DEG.C
	AMPS2 429. AMPS		T02HTR 607.5 DEG.C	
TWINDP 22.3 DEG.C	VOLTG 2.02 VOLTS	MEANBP 5503. KPA	T03HTR 612.9 DEG.C	
TDLDP 0.96 DEG.C		MEANC 5532. KPA	T04HTR 606.0 DEG.C	
TWODPR 23.9 DEG.C			T05HTR 616.0 DEG.C	
			T06HTR 606.1 DEG.C	
			T07HTR 605.4 DEG.C	
			T08HTR 583.7 DEG.C	
			T09HTR 606.5 DEG.C	
HEAT TO COOLER	CALCULATED PARAMETERS	VIBRATION	REMOTE CALCULATIONS	T10HTR 594.1 DEG.C
FLOC LR 4.41 L/MIN	1 PWRIN 1904. WATTS	VX1HOR 0.2 CM/S	PWRROUT 418. WATTS	T11HTR 579.1 DEG.C
TWINCL 25.1 DEG.C	2 QCOOLR 1559. WATTS	VY1VER 4.7 CM/S	INDPWR 443. WATTS	T12HTR 586.0 DEG.C
TDLCL 5.09 DEG.C	3 QDSHPT 280. WATTS		PISTST 1.82 CM	
TWOCLR 28.93 DEG.C	4 EXTEFF 21.9 %	PHASE ANGLES	DISPST 1.95 CM	
	5 TAVHTR 600.2 DEG.C	PADISP 56.5 DEG.	DYNAMIC CALCULATIONS	T13REG***** DEG.C
	6 INTEFF 21.1 %	PAPRES -22.1 DEG.	PAMPC 502. KPA	T14REG 519.7 DEG.C
	8 AMPS 941. AMPS		DISPCP 2.07 CM	T15REG 384.2 DEG.C
	9 QDISPG 3. WATTS	ENGINE SPEED	PISTCP 2.40 CM	T16REG 376.7 DEG.C
	10 QDISP 15. WATTS	FREQ 26.7 HZ	PDYNDB***** KPA	T17REG 363.9 DEG.C
	11 QREG1 121. WATTS		PDLCLR 2.04 KPA	T18REG 369.8 DEG.C
	12 QREG2 122. WATTS		PDLREG 28.17 KPA	T19REG 220.3 DEG.C
	13 QREG3 38. WATTS		PDLDIS 48.87 KPA	T03HED***** DEG.C
	14 PFP 649.2 KPA/CM			
	15 PFD 232.3 KPA/CM			
	16 NBEALE 0.00608			

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APPENDIX C. - CONTINUED.

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 08/03/84 14:42:44.30 RDG 1067

FLUID HELIUM BAROM 14.342 PSI REGENERATOR 1 DISPLACER 1 STANDARD PISTON

HEAT TO DASHPOT COOLING		POWER IN	ENGINE CHARGE PRESSURE	GAS TEMPERATURES	SURFACE TEMPERATURES
FLODP	4.21 L/MIN	AMPS1 543. AMPS	PRESUP 5562. KPA	TGEXP 563.3 DEG.C	T01HTR 599.9 DEG.C
		AMPS2 455. AMPS			T02HTR 606.4 DEG.C
TWINDP	22.4 DEG.C	VOLTG 2.15 VOLTS	MEANBP 5482. KPA	TGRECH 561.9 DEG.C	T03HTR 612.9 DEG.C
TDLDP	1.14 DEG.C		MEANCP 5513. KPA	TGREGC 76.6 DEG.C	T04HTR 605.8 DEG.C
TWODPR	24.0 DEG.C			TGCOMP 42.0 DEG.C	T05HTR 615.8 DEG.C
				TGBOUN 34.5 DEG.C	T06HTR 606.4 DEG.C
					T07HTR 605.5 DEG.C
					T08HTR 583.5 DEG.C
					T09HTR 608.0 DEG.C
					T10HTR 591.7 DEG.C
					T11HTR 579.4 DEG.C
					T12HTR 582.5 DEG.C
HEAT TO COOLER		CALCULATED PARAMETERS	VIBRATION	REMOTE CALCULATIONS	
FLOCLR	4.40 L/MIN	1 PWRIN 2142. WATTS	VX1HOR 0.2 CM/S	PWRROUT 495. WATTS	T13REG***** DEG.C
TWINCL	25.0 DEG.C	2 QCOOLR 1692. WATTS	VY1VER 5.2 CM/S	INDPWR 524. WATTS	T14REG 518.5 DEG.C
TDLCL	5.54 DEG.C	3 QDSHPT 335. WATTS		PISTST 2.01 CM	T15REG 384.1 DEG.C
TWOCLR	29.30 DEG.C	4 EXTEFF 23.1 %	PHASE ANGLES	DISPST 2.07 CM	T16REG 379.5 DEG.C
		5 TAVHTR 599.8 DEG.C	PADISP 57.8 DEG.	DYNAMIC CALCULATIONS	T17REG 368.1 DEG.C
		6 INTEFF 22.6 %	PAPRES -20.9 DEG.	PAMPC 699. KPA	T18REG 368.6 DEG.C
		8 AMPS 998. AMPS		DISPCP 2.13 CM	T19REG 221.5 DEG.C
		9 QDISPG 3. WATTS	ENGINE SPEED	PISTCP 2.45 CM	
		10 QDISP 15. WATTS	FREQ 26.9 HZ	PDYNDB***** KPA	
		11 QREG1 119. WATTS		PDLCLR 2.55 KPA	
		12 QREG2 122. WATTS		PDLREG 31.90 KPA	
		13 QREG3 38. WATTS		PDLDIS 54.30 KPA	
		14 PFP 805.9 KPA/CM			T03HED***** DEG.C
		15 PFD 284.8 KPA/CM			
		16 NBEALE 0.00652			

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 08/03/84 14:47:26.35 RDG 1068

FLUID HELIUM BAROM 14.342 PSI REGENERATOR 1 DISPLACER 1 STANDARD PISTON

HEAT TO DASHPOT COOLING		POWER IN	ENGINE CHARGE PRESSURE	GAS TEMPERATURES	SURFACE TEMPERATURES
FLODP	4.21 L/MIN	AMPS1 575. AMPS	PRESUP 5565. KPA	TGEXP 560.8 DEG.C	T01HTR 602.3 DEG.C
		AMPS2 478. AMPS			T02HTR 605.2 DEG.C
TWINDP	22.4 DEG.C	VOLTG 2.27 VOLTS	MEANBP 5503. KPA	TGRECH 562.5 DEG.C	T03HTR 614.6 DEG.C
TDLDP	1.31 DEG.C		MEANCP 5536. KPA	TGREGC 78.9 DEG.C	T04HTR 605.5 DEG.C
TWODPR	24.3 DEG.C			TGCOMP 43.5 DEG.C	T05HTR 616.9 DEG.C
				TGBOUN 35.0 DEG.C	T06HTR 606.9 DEG.C
					T07HTR 605.7 DEG.C
					T08HTR 584.7 DEG.C
					T09HTR 610.2 DEG.C
					T10HTR 590.8 DEG.C
					T11HTR 580.2 DEG.C
					T12HTR 579.9 DEG.C
HEAT TO COOLER		CALCULATED PARAMETERS	VIBRATION	REMOTE CALCULATIONS	
FLOCLR	4.41 L/MIN	1 PWRIN 2387. WATTS	VX1HOR 0.2 CM/S	PWRROUT 570. WATTS	T13REG***** DEG.C
TWINCL	25.1 DEG.C	2 QCOOLR 1833. WATTS	VY1VER 5.8 CM/S	INDPWR 602. WATTS	T14REG 517.8 DEG.C
TDLCL	5.99 DEG.C	3 QDSHPT 383. WATTS		PISTST 2.20 CM	T15REG 385.2 DEG.C
TWOCLR	29.80 DEG.C	4 EXTEFF 23.9 %	PHASE ANGLES	DISPST 2.19 CM	T16REG 381.9 DEG.C
		5 TAVHTR 600.2 DEG.C	PADISP 58.1 DEG.	DYNAMIC CALCULATIONS	T17REG 371.8 DEG.C
		6 INTEFF 23.7 %	PAPRES -19.8 DEG.	PAMPC 768. KPA	T18REG 369.8 DEG.C
		8 AMPS 1053. AMPS		DISPCP 2.16 CM	T19REG 223.8 DEG.C
		9 QDISPG 3. WATTS	ENGINE SPEED	PISTCP 2.44 CM	
		10 QDISP 15. WATTS	FREQ 27.0 HZ	PDYNDB***** KPA	
		11 QREG1 118. WATTS		PDLCLR 2.72 KPA	
		12 QREG2 120. WATTS		PDLREG 35.98 KPA	
		13 QREG3 37. WATTS		PDLDIS 60.75 KPA	
		14 PFP 804.1 KPA/CM			T03HED***** DEG.C
		15 PFD 279.2 KPA/CM			
		16 NBEALE 0.00680			

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 08/03/84 14:52:23.35 RDG 1069

FLUID HELIUM BAROM 14.342 PSI REGENERATOR 1 DISPLACER 1 STANDARD PISTON

HEAT TO DASHPOT COOLING		POWER IN	ENGINE CHARGE PRESSURE	GAS TEMPERATURES	SURFACE TEMPERATURES
FLODP	4.22 L/MIN	AMPS1 607. AMPS	PRESUP 5561. KPA	TGEXP 558.0 DEG.C	T01HTR 603.6 DEG.C
		AMPS2 500. AMPS			T02HTR 604.9 DEG.C
TWINDP	22.4 DEG.C	VOLTG 2.39 VOLTS	MEANBP 5513. KPA	TGRECH 562.2 DEG.C	T03HTR 615.8 DEG.C
TDLDP	1.51 DEG.C		MEANCP 5511. KPA	TGREGC 81.1 DEG.C	T04HTR 604.8 DEG.C
TWODPR	24.5 DEG.C			TGCOMP 45.8 DEG.C	T05HTR 618.0 DEG.C
				TGBOUN 36.3 DEG.C	T06HTR 608.0 DEG.C
					T07HTR 606.6 DEG.C
					T08HTR 585.1 DEG.C
					T09HTR 611.2 DEG.C
					T10HTR 589.3 DEG.C
					T11HTR 579.9 DEG.C
					T12HTR 577.8 DEG.C
HEAT TO COOLER		CALCULATED PARAMETERS	VIBRATION	REMOTE CALCULATIONS	
FLOCLR	4.41 L/MIN	1 PWRIN 2642. WATTS	VX1HOR 0.3 CM/S	PWRROUT 646. WATTS	T13REG***** DEG.C
TWINCL	25.1 DEG.C	2 QCOOLR 1979. WATTS	VY1VER 6.5 CM/S	INDPWR 681. WATTS	T14REG 517.7 DEG.C
TDLCL	6.46 DEG.C	3 QDSHPT 441. WATTS		PISTST 2.41 CM	T15REG 386.7 DEG.C
TWOCLR	30.43 DEG.C	4 EXTEFF 24.5 %	PHASE ANGLES	DISPST 2.32 CM	T16REG 383.2 DEG.C
		5 TAVHTR 600.4 DEG.C	PADISP 58.5 DEG.	DYNAMIC CALCULATIONS	T17REG 373.7 DEG.C
		6 INTEFF 24.6 %	PAPRES -18.6 DEG.	PAMPC 827. KPA	T18REG 370.7 DEG.C
		8 AMPS 1107. AMPS		DISPCP 2.19 CM	T19REG 226.8 DEG.C
		9 QDISPG 3. WATTS	ENGINE SPEED	PISTCP 2.44 CM	
		10 QDISP 15. WATTS	FREQ 27.0 HZ	PDYNDB***** KPA	
		11 QREG1 117. WATTS		PDLCLR 3.56 KPA	
		12 QREG2 119. WATTS		PDLREG 40.05 KPA	
		13 QREG3 37. WATTS		PDLDIS 67.20 KPA	
		14 PFP 785.9 KPA/CM			T03HED***** DEG.C
		15 PFD 266.8 KPA/CM			
		16 NBEALE 0.00704			

APPENDIX C. - CONTINUED.

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 08/03/84 14:58:23.35 RDG 1070

FLUID HELIUM		BAROM 14.342 PSI REGENERATOR 1 DISPLACER 1 STANDARD PISTON				
HEAT TO DASHPOT COOLING		POWER IN		ENGINE CHARGE PRESSURE		GAS TEMPERATURES
FLODP	4.20 L/MIN	AMPS1	635. AMPS	PRESUP	5553. KPA	TGEXP 555.0 DEG.C
TWINDP	22.4 DEG.C	AMPS2	521. AMPS			T01HTR 599.7 DEG.C
TDLDP	1.70 DEG.C	VOLTG	2.49 VOLTS	MEANBP	5494. KPA	T02HTR 606.6 DEG.C
TWODPR	24.7 DEG.C			MEANCP	5531. KPA	T03HTR 614.7 DEG.C
						T04HTR 601.3 DEG.C
						T05HTR 619.1 DEG.C
						T06HTR 609.4 DEG.C
						T07HTR 608.6 DEG.C
						T08HTR 580.8 DEG.C
						T09HTR 607.0 DEG.C
HEAT TO COOLER		CALCULATED PARAMETERS		VIBRATION		REMOTE CALCULATIONS
FLOCLR	4.40 L/MIN	1	PWRIN 2879. WATTS	VX1HOR	0.3 CM/S	PWRROUT 720. WATTS
TWINCL	25.2 DEG.C	2	QCOOLR 2137. WATTS	VY1VER	7.1 CM/S	INDPWR 759. WATTS
TDLCL	7.00 DEG.C	3	QDSHPT 495. WATTS			PISTST 2.61 CM
TWOCLR	30.99 DEG.C	4	EXTEFF 25.0 %			DISPST 2.46 CM
		5	TAVHTR 598.8 DEG.C	PADISP	58.7 DEG.	
		6	INTEFF 25.2 %	PAPRES	-18.0 DEG.	DYNAMIC CALCULATIONS
		8	AMPS 1156. AMPS			PAMPC 910. KPA
		9	QDISPG 3. WATTS			DISPCP 2.25 CM
		10	QDISP 14. WATTS	ENGINE SPEED		PISTCP 2.46 CM
		11	QREG1 108. WATTS	FREQ	26.9 HZ	PDYNDB***** KPA
		12	QREG2 130. WATTS			PDLCLR 4.41 KPA
		13	QPEG3 37. WATTS			PDLREG 42.43 KPA
		14	PFP 795.4 KPA/CM			PDLDIS 71.95 KPA
		15	PFD 267.8 KPA/CM			
		16	NBEALE 0.00729			T03HED***** DEG.C

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 08/03/84 15:03:44.35 RDG 1071

FLUID HELIUM		BAROM 14.342 PSI REGENERATOR 1 DISPLACER 1 STANDARD PISTON				
HEAT TO DASHPOT COOLING		POWER IN		ENGINE CHARGE PRESSURE		GAS TEMPERATURES
FLODP	4.18 L/MIN	AMPS1	680. AMPS	PRESUP	5546. KPA	TGEXP 550.9 DEG.C
TWINDP	22.4 DEG.C	AMPS2	558. AMPS			T01HTR 596.8 DEG.C
TDLDP	1.91 DEG.C	VOLTG	2.68 VOLTS	MEANBP	5489. KPA	T02HTR 610.6 DEG.C
TWODPR	24.9 DEG.C			MEANCP	5530. KPA	T03HTR 614.7 DEG.C
						T04HTR 598.6 DEG.C
						T05HTR 621.7 DEG.C
						T06HTR 611.7 DEG.C
						T07HTR 611.3 DEG.C
						T08HTR 577.1 DEG.C
						T09HTR 602.4 DEG.C
HEAT TO COOLER		CALCULATED PARAMETERS		VIBRATION		REMOTE CALCULATIONS
FLOCLR	4.41 L/MIN	1	PWRIN 3315. WATTS	VX1HOR	0.3 CM/S	PWRROUT 785. WATTS
TWINCL	25.3 DEG.C	2	QCOOLR 2441. WATTS	VY1VER	7.6 CM/S	INDPWR 833. WATTS
TDLCL	7.97 DEG.C	3	QDSHPT 554. WATTS			PISTST 2.79 CM
TWOCLR	32.10 DEG.C	4	EXTEFF 23.7 %			DISPST 2.55 CM
		5	TAVHTR 598.1 DEG.C	PADISP	59.5 DEG.	
		6	INTEFF 24.3 %	PAPRES	-17.3 DEG.	DYNAMIC CALCULATIONS
		8	AMPS 1238. AMPS			PAMPC 965. KPA
		9	QDISPG 3. WATTS			DISPCP 2.31 CM
		10	QDISP 14. WATTS	ENGINE SPEED		PISTCP 2.44 CM
		11	QREG1 92. WATTS	FREQ	26.8 HZ	PDYNDB***** KPA
		12	QREG2 152. WATTS			T17REG 298.4 DEG.C
		13	QREG3 36. WATTS			T18REG 311.2 DEG.C
		14	PFP 780.6 KPA/CM			T19REG 198.0 DEG.C
		15	PFD 261.2 KPA/CM			
		16	NBEALE 0.00744			T03HED***** DEG.C

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 08/03/84 15:07:17.40 RDG 1072

FLUID HELIUM		BAROM 14.342 PSI REGENERATOR 1 DISPLACER 1 STANDARD PISTON				
HEAT TO DASHPOT COOLING		POWER IN		ENGINE CHARGE PRESSURE		GAS TEMPERATURES
FLODP	4.17 L/MIN	AMPS1	696. AMPS	PRESUP	5553. KPA	TGEXP 548.3 DEG.C
TWINDP	22.5 DEG.C	AMPS2	573. AMPS			T01HTR 594.4 DEG.C
TDLDP	1.96 DEG.C	VOLTG	2.75 VOLTS	MEANBP	5494. KPA	T02HTR 613.1 DEG.C
TWODPR	25.0 DEG.C			MEANCP	5536. KPA	T03HTR 614.0 DEG.C
						T04HTR 597.7 DEG.C
						T05HTR 622.3 DEG.C
						T06HTR 612.6 DEG.C
						T07HTR 612.1 DEG.C
						T08HTR 574.5 DEG.C
						T09HTR 599.4 DEG.C
HEAT TO COOLER		CALCULATED PARAMETERS		VIBRATION		REMOTE CALCULATIONS
FLOCLR	4.42 L/MIN	1	PWRIN 3489. WATTS	VX1HOR	0.3 CM/S	PWRROUT 756. WATTS
TWINCL	25.5 DEG.C	2	QCOOLR 2559. WATTS	VY1VER	7.7 CM/S	INDPWR 806. WATTS
TDLCL	8.35 DEG.C	3	QDSHPT 566. WATTS			PISTST 2.83 CM
TWOCLR	32.86 DEG.C	4	EXTEFF 21.7 %			DISPST 2.44 CM
		5	TAVHTR 597.5 DEG.C	PADISP	59.2 DEG.	
		6	INTEFF 22.8 %	PAPRES	-16.2 DEG.	DYNAMIC CALCULATIONS
		8	AMPS 1269. AMPS			PAMPC 999. KPA
		9	QDISPG 3. WATTS			DISPCP 2.34 CM
		10	QDISP 14. WATTS	ENGINE SPEED		PISTCP 2.43 CM
		11	QREG1 84. WATTS	FREQ	26.7 HZ	PDYNDB***** KPA
		12	QREG2 162. WATTS			T17REG 270.4 DEG.C
		13	QREG3 36. WATTS			T18REG 288.0 DEG.C
		14	PFP 794.0 KPA/CM			T19REG 184.7 DEG.C
		15	PFD 265.6 KPA/CM			
		16	NBEALE 0.00709			T03HED***** DEG.C

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APPENDIX C. - CONTINUED.

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 08/06/84 14:31:24.59 RDG 1075

FLUID HELIUM		BAROM 14.288 PSI REGENERATOR 1 DISPLACER 1 STANDARD PISTON			
HEAT TO DASHPOT COOLING		POWER IN	ENGINE CHARGE PRESSURE	GAS TEMPERATURES	SURFACE TEMPERATURES
FLODP	3.84 L/MIN	AMPS1 448. AMPS	PRESUP 4145. KPA	TGEXP 562.2 DEG.C	T01HTR 606.5 DEG.C
		AMPS2 382. AMPS			T02HTR 598.6 DEG.C
TWINDP	22.8 DEG.C	VOLTG 1.78 VOLTS	MEANBP 4011. KPA	TGRECH 562.2 DEG.C	T03HTR 613.7 DEG.C
TIDLDP	0.32 DEG.C		MEANCP 4028. KPA	TGRECC 66.0 DEG.C	T04HTR 607.6 DEG.C
TWODPR	23.8 DEG.C			TGCOMP 33.8 DEG.C	T05HTR 611.9 DEG.C
				TGBOUN 28.7 DEG.C	T06HTR 596.9 DEG.C
					T07HTR 598.3 DEG.C
					T08HTR 593.9 DEG.C
					T09HTR 606.9 DEG.C
HEAT TO COOLER		CALCULATED PARAMETERS	VIBRATION	REMOTE CALCULATIONS	T10HTR 598.1 DEG.C
FLOCRL	4.31 L/MIN	1 PWRRIN 1481. WATTS	VX1HOR 0.2 CM/S	PWRROUT 280. WATTS	T11HTR 585.3 DEG.C
TWINCL	25.2 DEG.C	2 QCoolR 890. WATTS	VY1VER 4.1 CM/S	INDPWR 290. WATTS	T12HTR 584.7 DEG.C
TDLCL	2.97 DEG.C	3 QDShpt 86. WATTS		PISTST 1.82 CM	
TWOCLR	27.79 DEG.C	4 EXTEFF 18.9 %	PHASE ANGLES	DISPST 1.97 CM	
		5 TAVHTR 600.2 DEG.C	PADISP 55.9 DEG.		
		6 INTEFF 23.9 %	PAPRES -23.8 DEG.	DYNAMIC CALCULATIONS	
		8 AMPS 830. AMPS		PAMPC 438. KPA	T13REG***** DEG.C
		9 QDISPG 3. WATTS	ENGINE SPEED	DISPCP 1.76 CM	T14REG 507.9 DEG.C
		10 QDISP 15. WATTS	FREQ 22.8 HZ	PISTCP 2.34 CM	T15REG 366.8 DEG.C
		11 QREG1 129. WATTS		PDYNDB***** KPA	T16REG 363.4 DEG.C
		12 QREG2 118. WATTS		PDICLR 1.19 KPA	T17REG 360.7 DEG.C
		13 QREG3 38. WATTS		PDLPEG 17.65 KPA	T18REG 361.9 DEG.C
		14 PFP 573.1 KPA/CM		PDLDIS 31.90 KPA	T19REG 203.1 DEG.C
		15 PFD 216.8 KPA/CM			T03HED***** DEG.C
		16 NBEALE 0.00656			

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 08/06/84 14:37:54.59 RDG 1076

FLUID HELIUM		BAROM 14.288 PSI REGENERATOR 1 DISPLACER 1 STANDARD PISTON			
HEAT TO DASHPOT COOLING		POWER IN	ENGINE CHARGE PRESSURE	GAS TEMPERATURES	SURFACE TEMPERATURES
FLODP	3.85 L/MIN	AMPS1 464. AMPS	PRESUP 4155. KPA	TGEXP 560.4 DEG.C	T01HTR 605.6 DEG.C
		AMPS2 396. AMPS			T02HTR 600.3 DEG.C
TWINDP	22.8 DEG.C	VOLTG 1.85 VOLTS	MEANBP 4008. KPA	TGRECH 562.3 DEG.C	T03HTR 614.9 DEG.C
TIDLDP	0.45 DEG.C		MEANCP 4025. KPA	TGRECC 67.6 DEG.C	T04HTR 605.9 DEG.C
TWODPR	23.9 DEG.C			TGCOMP 36.1 DEG.C	T05HTR 614.6 DEG.C
				TGBOUN 29.0 DEG.C	T06HTR 597.9 DEG.C
					T07HTR 599.1 DEG.C
					T08HTR 592.2 DEG.C
					T09HTR 606.3 DEG.C
HEAT TO COOLER		CALCULATED PARAMETERS	VIBRATION	REMOTE CALCULATIONS	T10HTR 597.4 DEG.C
FLOCRL	4.31 L/MIN	1 PWRRIN 1589. WATTS	VX1HOR 0.2 CM/S	PWRROUT 327. WATTS	T11HTR 584.1 DEG.C
TWINCL	25.2 DEG.C	2 QCoolR 968. WATTS	VY1VER 4.4 CM/S	INDPWR 345. WATTS	T12HTR 586.1 DEG.C
TDLCL	3.24 DEG.C	3 QDShpt 119. WATTS		PISTST 1.99 CM	
TWOCLR	28.07 DEG.C	4 EXTEFF 20.6 %	PHASE ANGLES	DISPST 2.13 CM	
		5 TAVHTR 600.4 DEG.C	PADISP 55.7 DEG.	DYNAMIC CALCULATIONS	
		6 INTEFF 25.3 %	PAPRES -22.8 DEG.	PAMPC 472. KPA	T13REG***** DEG.C
		8 AMPS 860. AMPS		DISPCP 2.05 CM	T14REG 511.9 DEG.C
		9 QDISPG 3. WATTS	ENGINE SPEED	PISTCP 2.36 CM	T15REG 373.5 DEG.C
		10 QDISP 15. WATTS	FREQ 22.8 HZ	PDYNDB***** KPA	T16REG 365.9 DEG.C
		11 QREG1 127. WATTS		PDICLR 1.36 KPA	T17REG 362.8 DEG.C
		12 QREG2 118. WATTS		PDLREG 21.72 KPA	T18REG 366.2 DEG.C
		13 QREG3 38. WATTS		PDLDIS 36.66 KPA	T19REG 209.5 DEG.C
		14 PFP 562.5 KPA/CM			T03HED***** DEG.C
		15 PFD 208.3 KPA/CM			
		16 NBEALE 0.00700			

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 08/06/84 14:42:21.59 RDG 1077

FLUID HELIUM		BAROM 14.288 PSI REGENERATOR 1 DISPLACER 1 STANDARD PISTON			
HEAT TO DASHPOT COOLING		POWER IN	ENGINE CHARGE PRESSURE	GAS TEMPERATURES	SURFACE TEMPERATURES
FLODP	3.83 L/MIN	AMPS1 501. AMPS	PRESUP 4150. KPA	TGEXP 556.6 DEG.C	T01HTR 603.9 DEG.C
		AMPS2 420. AMPS			T02HTR 599.1 DEG.C
TWINDP	22.9 DEG.C	VOLTG 1.98 VOLTS	MEANBP 4000. KPA	TGRECH 560.5 DEG.C	T03HTR 613.3 DEG.C
TIDLDP	0.57 DEG.C		MEANCP 4020. KPA	TGRECC 69.3 DEG.C	T04HTR 605.2 DEG.C
TWODPR	24.1 DEG.C			TGCOMP 38.1 DEG.C	T05HTR 613.6 DEG.C
				TGBOUN 29.9 DEG.C	T06HTR 599.1 DEG.C
					T07HTR 599.9 DEG.C
					T08HTR 589.4 DEG.C
					T09HTR 606.7 DEG.C
HEAT TO COOLER		CALCULATED PARAMETERS	VIBRATION	REMOTE CALCULATIONS	T10HTR 593.7 DEG.C
FLOCRL	4.29 L/MIN	1 PWRRIN 1824. WATTS	VX1HOR 0.2 CM/S	PWRROUT 387. WATTS	T11HTR 582.2 DEG.C
TWINCL	25.2 DEG.C	2 QCoolR 1071. WATTS	VY1VER 4.9 CM/S	INDPWR 407. WATTS	T12HTR 583.3 DEG.C
TDLCL	3.59 DEG.C	3 QDShpt 151. WATTS		PISTST 2.20 CM	
TWOCLR	28.42 DEG.C	4 EXTEFF 21.2 %	PHASE ANGLES	DISPST 2.27 CM	
		5 TAVHTR 599.1 DEG.C	PADISP 57.1 DEG.	DYNAMIC CALCULATIONS	
		6 INTEFF 26.5 %	PAPRES -21.7 DEG.	PAMPC 541. KPA	T13REG***** DEG.C
		8 AMPS 921. AMPS		DISPCP 2.06 CM	T14REG 512.1 DEG.C
		9 QDISPG 3. WATTS	ENGINE SPEED	PISTCP 2.39 CM	T15REG 376.4 DEG.C
		10 QDISP 15. WATTS	FREQ 23.0 HZ	PDYNDB***** KPA	T16REG 369.4 DEG.C
		11 QREG1 123. WATTS		PDICLR 1.87 KPA	T17REG 363.7 DEG.C
		12 QREG2 120. WATTS		PDLREG 24.44 KPA	T18REG 364.3 DEG.C
		13 QREG3 38. WATTS		PDLDIS 40.73 KPA	T19REG 212.9 DEG.C
		14 PFP 574.3 KPA/CM			T03HED***** DEG.C
		15 PFD 209.8 KPA/CM			
		16 NBEALE 0.00746			

APPENDIX C. - CONTINUED.

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 08/06/84 14:47:21.59 RDG 1078

FLUID HELIUM		BAROM 14.288 PSI		REGENERATOR 1	DISPLACER 1	STANDARD PISTON	SURFACE TEMPERATURES
HEAT TO DASHPOT COOLING	FLODP	3.82 L/MIN	POWER IN	AMFS1	516. AMPS	ENGINE CHARGE PRESSURE	GAS TEMPERATURES
				AMFS2	434. AMPS	PRESUP 4146. KPA	TGEXP 555.0 DEG.C
TWINDP	22.9 DEG.C	VOLTG	2.04 VOLTS			MEANBP 3995. KPA	TGREGH 561.3 DEG.C
TDLDP	0.80 DEG.C					MEANCP 4018. KPA	TGREGC 71.0 DEG.C
TWODPR	24.3 DEG.C						TGCOMP 40.2 DEG.C
							TGBOUN 30.9 DEG.C
HEAT TO COOLER	FLOCLR	4.30 L/MIN	CALCULATED PARAMETERS			VIBRATION	REMOTE CALCULATIONS
	TWINCL	25.2 DEG.C	1 PWRIN 1939. WATT			VX1HOR 0.2 CM/S	PWRROUT 446. WATTS
	TDLCL	3.94 DEG.C	2 QCOOLR 1176. WATTS			VY1VER 5.4 CM/S	INDFWR 466. WATTS
	TWOCLR	28.82 DEG.C	3 QDSHPT 212. WATTS				FISTST 2.41 CM
		4 EXTEFF 23.0 %					DISPST 2.39 CM
		5 TAVHTR 599.5 DEG.C			PHASE ANGLES	DYNAMIC CALCULATIONS	
		6 INTEFF 27.5 %			PADISP 58.1 DEG.	PAMPC 576. KPA	T13REG***** DEG.C
		8 AMFS			PAPRES -20.3 DEG.	DISPCP 2.13 CM	T14REG 512.8 DEG.C
		9 QDISPG			ENGINE SPEED	PISTCP 2.37 CM	T15REG 378.0 DEG.C
		10 QDISP			FREQ 23.0 HZ	PDYNDB***** KPA	T16REG 371.9 DEG.C
		11 QREG1				PDLCLR 2.04 KPA	T17REG 367.3 DEG.C
		12 QREG2				PDLREG 27.15 KPA	T18REG 365.8 DEG.C
		13 QREG3				PDLDIS 45.48 KPA	T19REG 215.0 DEG.C
		14 FFP					T03HED***** DEG.C
		15 PFD					
		16 NBEALE	0.00784				

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 08/06/84 14:52:24.59 RDG 1079

FLUID HELIUM		BAROM 14.288 PSI		REGENERATOR 1	DISPLACER 1	STANDARD PISTON	SURFACE TEMPERATURES
HEAT TO DASHPOT COOLING	FLODP	4.08 L/MIN	POWER IN	AMFS1	539. AMPS	ENGINE CHARGE PRESSURE	GAS TEMPERATURES
				AMFS2	451. AMPS	PRESUP 4143. KPA	TGEXP 553.1 DEG.C
TWINDP	23.0 DEG.C	VOLTG	2.13 VOLTS			MEANBP 3988. KPA	TGREGH 560.1 DEG.C
TDLDP	0.81 DEG.C					MEANCP 4012. KPA	TGREGC 70.5 DEG.C
TWODPR	24.4 DEG.C						TGCOMP 41.6 DEG.C
							TGBOUN 32.0 DEG.C
HEAT TO COOLER	FLOCLR	4.31 L/MIN	CALCULATED PARAMETERS			VIBRATION	REMOTE CALCULATIONS
	TWINCL	25.2 DEG.C	1 PWRIN 2109. WATTS			VX1HOR 0.2 CM/S	PWPOUT 500. WATTS
	TDLCL	4.15 DEG.C	2 QCOOLR 1242. WATTS			VY1VER 5.8 CM/S	INDPWR 520. WATTS
	TWOCLR	29.17 DEG.C	3 QDSHPT 228. WATTS				PISTST 2.61 CM
		4 EXTEFF 23.7 %			PHASE ANGLES	DYNAMIC CALCULATIONS	
		5 TAVHTR 599.4 DEG.C			PADISP 58.4 DEG.	PAMPC 645. KPA	T13REG***** DEG.C
		6 INTEFF 28.7 %			PAPRES -19.7 DEG.	DISPCP 2.18 CM	T14REG 512.2 DEG.C
		8 AMFS			ENGINE SPEED	PISTCP 2.40 CM	T15REG 376.1 DEG.C
		9 QDISPG			FREQ 23.0 HZ	PDYNDB***** KPA	T16REG 367.6 DEG.C
		10 QDISP				PDLCLR 2.72 KPA	T17REG 363.5 DEG.C
		11 QREG1				PDLREG 29.53 KPA	T18REG 363.0 DEG.C
		12 QREG2				PDLDIS 49.21 KPA	T19REG 213.7 DEG.C
		13 QREG3					T03HED***** DEG.C
		14 FFP					
		15 PFD					
		16 NBEALE	0.00815				

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 08/06/84 14:58:30.59 RDG 1080

FLUID HELIUM		BAROM 14.288 PSI		REGENERATOR 1	DISPLACER 1	STANDARD PISTON	SURFACE TEMPERATURES
HEAT TO DASHPOT COOLING	FLODP	4.11 L/MIN	POWER IN	AMFS1	568. AMPS	ENGINE CHARGE PRESSURE	GAS TEMPERATURES
				AMFS2	475. AMPS	PRESUP 4141. KPA	TGEXP 551.4 DEG.C
TWINDP	23.1 DEG.C	VOLTG	2.25 VOLTS			MEANBP 3986. KPA	TGREGH 552.6 DEG.C
TDLDP	0.93 DEG.C					MEANCP 4010. KPA	TGREGC 65.5 DEG.C
TWODPR	24.7 DEG.C						TGCOMP 45.0 DEG.C
							TGBOUN 33.3 DEG.C
HEAT TO COOLER	FLOCLR	4.33 L/MIN	CALCULATED PARAMETERS			VIBRATION	REMOTE CALCULATIONS
	TWINCL	25.3 DEG.C	1 PWRIN 2342. WATTS			VX1HOR 0.2 CM/S	FWRROUT 567. WATTS
	TDLCL	4.67 DEG.C	2 QCOOLR 1402. WATTS			VY1VER 6.3 CM/S	INDPWR 592. WATTS
	TWOCLR	29.62 DEG.C	3 QDSHPT 266. WATTS				PISTST 2.82 CM
		4 EXTEFF 24.2 %			PHASE ANGLES	DYNAMIC CALCULATIONS	
		5 TAVHTR 600.6 DEG.C			PADISP 58.6 DEG.	PAMPC 699. KPA	T13REG***** DEG.C
		6 INTEFF 28.8 %			PAPRES -19.5 DEG.	DISPCP 2.21 CM	T14REG 506.8 DEG.C
		8 AMFS			ENGINE SPEED	PISTCP 2.50 CM	T15REG 358.9 DEG.C
		9 QDISPG			FREQ 22.8 HZ	PDYNDB***** KPA	T16REG 335.6 DEG.C
		10 QDISP				PDLCLR 3.53 KPA	T17REG 331.6 DEG.C
		11 QREG1				PDLREG 31.22 KPA	T18REG 342.7 DEG.C
		12 QREG2				PDLDIS 51.93 KPA	T19REG 201.7 DEG.C
		13 QREG3					T03HED***** DEG.C
		14 FFP					
		15 PFD					
		16 NBEALE	0.00860				

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APPENDIX C. - CONTINUED.

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 08/06/84 15:02:18.59 RDG 1081

FLUID HELIUM		BAROM 14.288 PSI REGENERATOR 1 DISPLACER 1 STANDARD PISTON					
HEAT TO DASHPOT COOLING		POWER IN		ENGINE CHARGE PRESSURE		GAS TEMPERATURES	
FLODP	4.10 L/MIN	AMPS1	588. AMPS	PRESUP	4139. KPA	TGEXP	548.9 DEG.C
		AMPS2	491. AMPS			TGREGH	549.8 DEG.C
TWINDP	23.1 DEG.C	VOLTG	2.32 VOLTS	MEANBP	3983. KPA	TGREGC	65.1 DEG.C
TDLDP	1.06 DEG.C			MEANCP	4011. KPA	TGCCMP	47.0 DEG.C
TWODPR	24.8 DEG.C					TGBOUN	33.9 DEG.C
HEAT TO COOLER		CALCULATED PARAMETERS		VIBRATION		REMOTE CALCULATIONS	
FLOCLR	4.34 L/MIN	1 PWRIN	2507. WATTS	VX1HOR	0.3 CM/S	PWRROUT	622. WATTS
TWINCL	25.3 DEG.C	2 QCOOLR	1500. WATTS	VY1VER	6.7 CM/S	INDPWR	647. WATTS
TDLCL	4.99 DEG.C	3 QDSHPT	302. WATTS			PISTST	3.01 CM
TWOCLR	29.90 DEG.C	4 EXTEFF	24.8 %			DISPST	2.86 CM
		5 TAVHTR	600.0 DEG.C	PADISP	58.9 DEG.		T13PEG***** DEG.C
		6 INTEFF	29.3 %	PAPRES	-19.3 DEG.		T14REG 505.5 DEG.C
		8 AMPS	1079. AMPS				T15PEG 354.8 DEG.C
		9 QDISPG	3. WATTS	ENGINE SPEED	FREQ	22.7 HZ	T16REG 328.7 DEG.C
		10 QDISP	14. WATTS				T17REG 324.6 DEG.C
		11 QREG1	113. WATTS				T18REG 338.1 DEG.C
		12 QREG2	136. WATTS				T19REG 198.9 DEG.C
		13 QREG3	38. WATTS				T03HED***** DEG.C
		14 PFP	557.0 KPA/CM				
		15 PFD	197.2 KPA/CM				
		16 NBEALE	0.00890				

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 08/08/84 13:16:33.40 RDG 1117

FLUID HELIUM		BAROM 14.239 PSI REGENERATOR 1 DISPLACER 1 STANDARD PISTON					
HEAT TO DASHPOT COOLING		POWER IN		ENGINE CHARGE PRESSURE		GAS TEMPERATURES	
FLODP	4.40 L/MIN	AMPS1	560. AMPS	PRESUP	7088. KPA	TGEXP	568.8 DEG.C
		AMPS2	479. AMPS			TGREGH	563.8 DEG.C
TWINDP	25.0 DEG.C	VOLTG	2.22 VOLTS	MEANBP	7007. KPA	TGREGC	100.3 DEG.C
TDLDP	1.19 DEG.C			MEANCP	7047. KPA	TGCCMP	52.1 DEG.C
TWODPR	26.7 DEG.C					TGBOUN	39.5 DEG.C
HEAT TO COOLER		CALCULATED PARAMETERS		VIBRATION		REMOTE CALCULATIONS	
FLOCLR	4.36 L/MIN	1 PWRIN	2303. WATTS	VX1HOR	0.3 CM/S	PWRROUT	503. WATTS
TWINCL	39.6 DEG.C	2 QCOOLR	1710. WATTS	VY1VER	6.0 CM/S	INDPWR	544. WATTS
TDLCL	5.69 DEG.C	3 QDSHPT	363. WATTS			PISTST	1.81 CM
TWOCLR	44.13 DEG.C	4 EXTEFF	21.9 %			DISPST	1.86 CM
		5 TAVHTR	599.5 DEG.C	PADISP	57.9 DEG.		T13REG***** DEG.C
		6 INTEFF	22.7 %	PAPRES	-18.7 DEG.		T14REG 521.2 DEG.C
		8 AMPS	1039. AMPS				T15PEG 389.1 DEG.C
		9 QDISPG	3. WATTS	ENGINE SPEED	FREQ	30.1 HZ	T16REG 392.1 DEG.C
		10 QDISP	15. WATTS				T17REG 384.9 DEG.C
		11 QREG1	118. WATTS				T18REG 378.9 DEG.C
		12 QREG2	115. WATTS				T19REG 232.9 DEG.C
		13 QREG3	36. WATTS				T03HED***** DEG.C
		14 PFP	1009.7 KPA/CM				
		15 PFD	324.6 KPA/CM				
		16 NBEALE	0.00512				

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 08/08/84 13:21:24.40 RDG 1118

FLUID HELIUM		BAROM 14.239 PSI REGENERATOR 1 DISPLACER 1 STANDARD PISTON					
HEAT TO DASHPOT COOLING		POWER IN		ENGINE CHARGE PRESSURE		GAS TEMPERATURES	
FLODP	4.39 L/MIN	AMPS1	597. AMPS	PRESUP	7085. KPA	TGEXP	565.3 DEG.C
		AMPS2	508. AMPS			TGREGH	563.9 DEG.C
TWINDP	25.1 DEG.C	VOLTG	2.36 VOLTS	MEANBP	7005. KPA	TGREGC	103.2 DEG.C
TDLDP	1.45 DEG.C			MEANCP	7047. KPA	TGCCMP	54.8 DEG.C
TWODPR	27.0 DEG.C					TGBOUN	40.7 DEG.C
HEAT TO COOLER		CALCULATED PARAMETERS		VIBRATION		REMOTE CALCULATIONS	
FLOCLR	4.37 L/MIN	1 PWRIN	2608. WATTS	VX1HOR	0.3 CM/S	PWRROUT	587. WATTS
TWINCL	39.7 DEG.C	2 QCOOLR	1842. WATTS	VY1VER	6.7 CM/S	INDPWR	631. WATTS
TDLCL	6.10 DEG.C	3 QDSHPT	442. WATTS			PISTST	2.01 CM
TWOCLR	44.66 DEG.C	4 EXTEFF	22.5 %			DISPST	1.97 CM
		5 TAVHTR	599.2 DEG.C	PADISP	57.9 DEG.		T13REG***** DEG.C
		6 INTEFF	24.2 %	PAPRES	-18.0 DEG.		T14REG 521.3 DEG.C
		8 AMPS	1105. AMPS				T15PEG 392.8 DEG.C
		9 QDISPG	3. WATTS	ENGINE SPEED	FREQ	30.2 HZ	T16REG 396.2 DEG.C
		10 QDISP	14. WATTS				T17REG 389.8 DEG.C
		11 QREG1	118. WATTS				T18REG 382.9 DEG.C
		12 QREG2	112. WATTS				T19REG 237.7 DEG.C
		13 QREG3	36. WATTS				T03HED***** DEG.C
		14 PFP	1009.5 KPA/CM				
		15 PFD	327.9 KPA/CM				
		16 NBEALE	0.00538				

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APPENDIX C. - CONTINUED.

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 08/08/84 13:26:36.40 RDG 1119

FLUID HELIUM		BAROM 14.234 PSI REGENERATOR 1 DISPLACER 1 STANDARD PISTON				
HEAT TO DASHPOT COOLING		POWER IN	ENGINE CHARGE PRESSURE	GAS TEMPERATURES	SURFACE TEMPERATURES	
FLODP	4.38 L/MIN	AMPS1 629. AMPS	PRESUP 7086. KPA	TGEXP 562.9 DEG.C	T01HTR	602.1 DEG.C
TWINDP	25.2 DEG.C	AMPS2 536. AMPS		TGREGH 563.0 DEG.C	T02HTR	604.2 DEG.C
TDLDP	1.63 DEG.C	VOLTG 2.49 VOLTS	MEANBP 7009. KPA	TGREGC 105.7 DEG.C	T03HTR	614.5 DEG.C
TWODPR	27.4 DEG.C		MEANCP 7053. KPA	TGCOMP 57.4 DEG.C	T04HTR	605.0 DEG.C
				TGBOUN 41.6 DEG.C	T05HTR	618.6 DEG.C
					T06HTR	607.2 DEG.C
					T07HTR	605.7 DEG.C
					T08HTR	582.5 DEG.C
					T09HTR	611.1 DEG.C
					T10HTR	588.5 DEG.C
					T11HTR	578.0 DEG.C
					T12HTR	578.3 DEG.C
HEAT TO COOLER		CALCULATED PARAMETERS	VIBRATION	REMOTE CALCULATIONS		
FLOCRL	4.36 L/MIN	1 PWRIN 2900. WATTS	VX1HOR 0.4 CM/S	PWRWRT 667. WATTS	T13REG***** DEG.C	
TWINCL	39.7 DEG.C	2 QCOOLR 2073. WATTS	VY1VER 7.3 CM/S	INDPWR 718. WATTS	T14REG 521.9 DEG.C	
TDLCL	6.88 DEG.C	3 QDSHPT 496. WATTS		PISTST 2.19 CM	T15REG 395.2 DEG.C	
TWOCLR	45.37 DEG.C	4 EXTEFF 23.0 %	PHASE ANGLES	DISPST 2.09 CM	T16REG 397.0 DEG.C	
		5 TAVHTR 599.6 DEG.C	PADISP 58.4 DEG.	DYNAMIC CALCULATIONS	T17REG 390.9 DEG.C	
		6 INTEFF 24.3 %	PAPRES -16.8 DEG.	PAMPC 970. KPA	T18REG 384.7 DEG.C	
		8 AMPS 1165. AMPS		DISPCP 2.26 CM	T19REG 241.6 DEG.C	
		9 QDISPG 3. WATTS	ENGINE SPEED	PISTCP 2.39 CM	T03HED***** DEG.C	
		10 QDISP 14. WATTS	FREQ 30.2 HZ	PDYNDB***** KPA		
		11 QREG1 116. WATTS		PDLCLR 4.24 KPA		
		12 QREG2 111. WATTS		PDLREG 45.48 KPA		
		13 QREG3 35. WATTS		PDLDIS 80.78 KPA		
		14 PFP 1003.3 KPA/CM				
		15 PFD 314.8 KPA/CM				
		16 NBEALE 0.00558				

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 08/08/84 13:31:27.40 RDG 1120

FLUID HELIUM		BAROM 14.234 PSI REGENERATOR 1 DISPLACER 1 STANDARD PISTON				
HEAT TO DASHPOT COOLING		POWER IN	ENGINE CHARGE PRESSURE	GAS TEMPERATURES	SURFACE TEMPERATURES	
FLODP	4.38 L/MIN	AMPS1 667. AMPS	PRESUP 7089. KPA	TGEXP 559.6 DEG.C	T01HTR	602.7 DEG.C
TWINDP	25.3 DEG.C	AMPS2 568. AMPS		TGREGH 561.7 DEG.C	T02HTR	604.0 DEG.C
TDLDP	1.97 DEG.C	VOLTG 2.64 VOLTS	MEANBP 7011. KPA	TGREGC 108.4 DEG.C	T03HTR	616.3 DEG.C
TWODPR	27.7 DEG.C		MEANCP 7061. KPA	TGCOMP 60.5 DEG.C	T04HTR	603.9 DEG.C
				TGBOUN 42.9 DEG.C	T05HTR	620.6 DEG.C
					T06HTR	608.3 DEG.C
					T07HTR	606.7 DEG.C
					T08HTR	582.1 DEG.C
					T09HTR	611.5 DEG.C
HEAT TO COOLER		CALCULATED PARAMETERS	VIBRATION	REMOTE CALCULATIONS		
FLOCRL	4.39 L/MIN	1 PWRIN 3258. WATTS	VX1HOR 0.4 CM/S	PWRROUT 757. WATTS	T10HTR	587.4 DEG.C
TWINCL	39.8 DEG.C	2 QCOOLR 2345. WATTS	VY1VER 8.0 CM/S	INDPWR 814. WATTS	T11HTR	576.6 DEG.C
TDLCL	7.74 DEG.C	3 QDSHPT 598. WATTS		PISTST 2.42 CM	T12HTR	576.3 DEG.C
TWOCLR	46.23 DEG.C	4 EXTEFF 23.2 %	PHASE ANGLES	DISPST 2.22 CM		
		5 TAVHTR 599.7 DEG.C	PADISP 58.4 DEG.	DYNAMIC CALCULATIONS	T13REG***** DEG.C	
		6 INTEFF 24.4 %	PAPRES -15.7 DEG.	PAMPC 1083. KPA	T14REG 522.0 DEG.C	
		8 AMPS 1234. AMPS		DISPCP 2.27 CM	T15REG 397.2 DEG.C	
		9 QDISPG 3. WATTS	ENGINE SPEED	PISTCP 2.38 CM	T16REG 397.8 DEG.C	
		10 QDISP 14. WATTS	FREQ 30.2 HZ	PDYNDB***** KPA	T17REG 391.7 DEG.C	
		11 QREG1 114. WATTS		PDLCLR 5.09 KPA	T18REG 386.3 DEG.C	
		12 QREG2 110. WATTS		PDLREG 51.25 KPA	T19REG 245.2 DEG.C	
		13 QREG3 35. WATTS		PDLDIS 89.26 KPA	T03HED***** DEG.C	
		14 PFP 1010.9 KPA/CM				
		15 PFD 309.5 KPA/CM				
		16 NBEALE 0.00575				

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 08/08/84 13:36:21.40 RDG 1121

FLUID HELIUM		BAROM 14.234 PSI REGENERATOR 1 DISPLACER 1 STANDARD PISTON				
HEAT TO DASHPOT COOLING		POWER IN	ENGINE CHARGE PRESSURE	GAS TEMPERATURES	SURFACE TEMPERATURES	
FLODP	4.37 L/MIN	AMPS1 702. AMPS	PRESUP 7093. KPA	TGEXP 557.0 DEG.C	T01HTR	602.6 DEG.C
TWINDP	25.4 DEG.C	AMPS2 595. AMPS		TGREGH 559.4 DEG.C	T02HTR	604.7 DEG.C
TDLDP	2.18 DEG.C	VOLTG 2.78 VOLTS	MEANBP 7012. KPA	TGREGC 109.0 DEG.C	T03HTR	616.7 DEG.C
TWODPR	28.0 DEG.C		MEANCP 7066. KPA	TGCOMP 64.0 DEG.C	T04HTR	603.0 DEG.C
				TGBOUN 44.0 DEG.C	T05HTR	621.4 DEG.C
					T06HTR	609.5 DEG.C
					T07HTR	608.0 DEG.C
					T08HTR	580.9 DEG.C
					T09HTR	611.3 DEG.C
HEAT TO COOLER		CALCULATED PARAMETERS	VIBRATION	REMOTE CALCULATIONS		
FLOCRL	4.36 L/MIN	1 PWRIN 3599. WATTS	VX1HOR 0.4 CM/S	PWRROUT 845. WATTS	T10HTR	586.0 DEG.C
TWINCL	39.9 DEG.C	2 QCOOLR 2532. WATTS	VY1VER 8.6 CM/S	INDPWR 907. WATTS	T11HTR	574.7 DEG.C
TDLCL	8.42 DEG.C	3 QDSHPT 662. WATTS		PISTST 2.61 CM	T12HTR	574.8 DEG.C
TWOCLR	46.99 DEG.C	4 EXTEFF 23.5 %	PHASE ANGLES	DISPST 2.35 CM		
		5 TAVHTR 599.5 DEG.C	PADISP 58.5 DEG.	DYNAMIC CALCULATIONS	T13REG***** DEG.C	
		6 INTEFF 25.0 %	PAPRES -14.9 DEG.	PAMPC 1171. KPA	T14REG 519.6 DEG.C	
		8 AMPS 1296. AMPS		DISPCP 2.29 CM	T15REG 391.9 DEG.C	
		9 QDISPG 3. WATTS	ENGINE SPEED	PISTCP 2.34 CM	T16REG 391.7 DEG.C	
		10 QDISP 14. WATTS	FREQ 30.3 HZ	PDYNDB***** KPA	T17REG 386.0 DEG.C	
		11 QREG1 111. WATTS		PDLCLR 6.11 KPA	T18REG 378.7 DEG.C	
		12 QREG2 114. WATTS		PDLREG 56.34 KPA	T19REG 241.7 DEG.C	
		13 QREG3 35. WATTS		PDLDIS 96.73 KPA	T03HED***** DEG.C	
		14 PFP 1007.1 KPA/CM				
		15 PFD 300.9 KPA/CM				
		16 NBEALE 0.00593				

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APPENDIX C. - CONTINUED.

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 08/08/84 13:41:21.40 RDG 1122

FLUID HELIUM BAROM 14.234 PSI REGENERATOR 1 DISPLACER 1 STANDARD PISTON

HEAT TO DASHPOT COOLING		POWER IN	ENGINE CHARGE PRESSURE	GAS TEMPERATURES	SURFACE TEMPERATURES
FLODP	4.37 L/MIN	AMPS1 744. AMPS	PRESUP 7093. KPA	TGEXP 553.0 DEG.C	T01HTR 600.3 DEG.C
		AMPS2 627. AMPS			T02HTR 606.8 DEG.C
TWINDP	25.6 DEG.C	VOLTG 2.91 VOLTS	MEANBP 7014. KPA	TGREGH 550.7 DEG.C	T03HTR 614.7 DEG.C
TDLDP	2.52 DEG.C		MEANCP 7072. KPA	TGREGC 104.8 DEG.C	T04HTR 601.2 DEG.C
TWODPR	28.5 DEG.C			TGCOMP 70.5 DEG.C	T05HTR 621.1 DEG.C
				TGBOUN 45.8 DEG.C	T06HTR 610.5 DEG.C
					T07HTR 608.9 DEG.C
					T08HTR 577.5 DEG.C
					T09HTR 608.8 DEG.C
					T10HTR 583.8 DEG.C
					T11HTR 569.9 DEG.C
					T12HTR 574.2 DEG.C
HEAT TO COOLER		CALCULATED PARAMETERS	VIBRATION	REMOTE CALCULATIONS	
FLOCLR	4.35 L/MIN	1 PWRIN 3994. WATTS	VX1HOR 0.4 CM/S	FWRROUT 912. WATTS	
TWINCL	39.9 DEG.C	2 QCOOLR 2889. WATTS	VY1VER 9.1 CM/S	INDPWR 976. WATTS	
TDLCL	9.62 DEG.C	3 QDSHPT 765. WATTS		PISTST 2.77 CM	
TWOCLR	48.16 DEG.C	4 EXTEFF 22.8 %	PHASE ANGLES	DISPST 2.44 CM	
		5 TAVHTR 598.1 DEG.C	PADISP 58.5 DEG.		DYNAMIC CALCULATIONS
		6 INTEFF 24.0 %	PAPRES -14.4 DEG.		PAMPC 1196. KPA
		8 AMPS 1371. AMPS		DISPCP 2.39 CM	T13REG***** DEG.C
		9 QDISPG 3. WATTS	ENGINE SPEED	PISTCP 2.38 CM	T14REG 505.1 DEG.C
		10 QDISP 14. WATTS	FREQ 30.1 HZ	PDYNDB***** KPA	T15REG 358.4 DEG.C
		11 QREG1 99. WATTS		PDLCLR 6.28 KPA	T16REG 355.7 DEG.C
		12 QREG2 135. WATTS		PDLREG 55.66 KPA	T17REG 348.0 DEG.C
		13 QREG3 35. WATTS		PDLDIS 97.07 KPA	T18REG 338.4 DEG.C
		14 PFP 967.1 KPA/CM			T19REG 216.9 DEG.C
		15 PFD 285.6 KPA/CM			T03HED***** DEG.C
		16 NBEALE 0.00606			

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 08/27/84 13:46:04.27 RDG 1196

FLUID HELIUM BAROM 14.332 PSI REGENERATOR 1 DISPLACER 1 STANDARD PISTON

HEAT TO DASHPOT COOLING		POWER IN	ENGINE CHARGE PRESSURE	GAS TEMPERATURES	SURFACE TEMPERATURES
FLODP	4.00 L/MIN	AMPS1 557. AMPS	PRESUP 7217. KPA	TGEXP 570.3 DEG.C	T01HTR 599.5 DEG.C
		AMPS2 461. AMPS			T02HTR 607.4 DEG.C
TWINDP	18.2 DEG.C	VOLTG 2.22 VOLTS	MEANBP 6995. KPA	TGREGH 563.9 DEG.C	T03HTR 611.0 DEG.C
TDLDP	1.58 DEG.C		MEANCP 7025. KPA	TGREGC 113.1 DEG.C	T04HTR 608.2 DEG.C
TWODPR	20.5 DEG.C			TGCOMP 61.3 DEG.C	T05HTR 615.2 DEG.C
				TGBOUN 37.7 DEG.C	T06HTR 607.0 DEG.C
					T07HTR 605.8 DEG.C
					T08HTR 582.1 DEG.C
					T09HTR 610.2 DEG.C

HEAT TO COOLER		CALCULATED PARAMETERS	VIBRATION	REMOTE CALCULATIONS	
FLOCLR	4.15 L/MIN	1 PWRIN 2263. WATTS	VX1HOR 0.4 CM/S	FWRROUT 473. WATTS	
TWINCL	53.9 DEG.C	2 QCOOLR 1278. WATTS	VY1VER 5.8 CM/S	INDPWR 512. WATTS	
TDLCL	4.48 DEG.C	3 QDSHPT 439. WATTS		PISTST 1.80 CM	
TWOCLR	57.49 DEG.C	4 EXTEFF 20.9 %	PHASE ANGLES	DISPST 1.82 CM	
		5 TAVHTR 600.1 DEG.C	PADISP 58.3 DEG.		DYNAMIC CALCULATIONS
		6 INTEFF 27.0 %	PAPRES -17.8 DEG.		PAMPC 787. KPA
		8 AMPS 1018. AMPS		DISPCP 2.06 CM	T13PEG***** DEG.C
		9 QDISPG 3. WATTS	ENGINE SPEED	PISTCP 2.36 CM	T14REG 522.9 DEG.C
		10 QDISP 14. WATTS	FREQ 30.1 HZ	PDYNDB***** KPA	T15REG 394.2 DEG.C
		11 QREG1 113. WATTS		PDLCLR 3.05 KPA	T16REG 396.6 DEG.C
		12 QREG2 116. WATTS		PDLREG 34.28 KPA	T17REG 385.4 DEG.C
		13 QREG3 35. WATTS		PDLDIS 61.43 KPA	T18REG 380.3 DEG.C
		14 PFP 997.0 KPA/CM			T19REG 241.3 DEG.C
		15 PFD 311.0 KPA/CM			T03HED***** DEG.C
		16 NBEALE 0.00486			

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 08/27/84 13:50:19.27 RDG 1197

FLUID HELIUM BAROM 14.332 PSI REGENERATOR 1 DISPLACER 1 STANDARD PISTON

HEAT TO DASHPOT COOLING		POWER IN	ENGINE CHARGE PRESSURE	GAS TEMPERATURES	SURFACE TEMPERATURES
FLODP	4.02 L/MIN	AMPS1 598. AMPS	PRESUP 7260. KPA	TGEXP 567.2 DEG.C	T01HTR 600.1 DEG.C
		AMPS2 490. AMPS			T02HTR 606.6 DEG.C
TWINDP	18.3 DEG.C	VOLTG 2.37 VOLTS	MEANBP 6995. KPA	TGREGH 562.6 DEG.C	T03HTR 612.9 DEG.C
TDLDP	1.80 DEG.C		MEANCP 7027. KPA	TGREGC 116.1 DEG.C	T04HTR 607.5 DEG.C
TWODPR	20.8 DEG.C			TGCOMP 63.2 DEG.C	T05HTR 617.2 DEG.C
				TGBOUN 38.8 DEG.C	T06HTR 607.8 DEG.C
					T07HTR 606.6 DEG.C
					T08HTR 581.6 DEG.C
					T09HTR 611.3 DEG.C

HEAT TO COOLER		CALCULATED PARAMETERS	VIBRATION	REMOTE CALCULATIONS	
FLOCLR	4.15 L/MIN	1 PWRIN 2582. WATTS	VX1HOR 0.5 CM/S	FWRROUT 557. WATTS	
TWINCL	54.0 DEG.C	2 QCOOLR 1444. WATTS	VY1VER 6.5 CM/S	INDPWR 602. WATTS	
TDLCL	5.06 DEG.C	3 QDSHPT 504. WATTS		PISTST 2.01 CM	
TWOCLR	58.16 DEG.C	4 EXTEFF 21.6 %	PHASE ANGLES	DISPST 1.96 CM	
		5 TAVHTR 600.2 DEG.C	PADISP 58.7 DEG.		DYNAMIC CALCULATIONS
		6 INTEFF 27.8 %	PAPRES -16.7 DEG.		PAMPC 886. KPA
		8 AMPS 1088. AMPS		DISPCP 2.15 CM	T13REG***** DEG.C
		9 QDISPG 3. WATTS	ENGINE SPEED	PISTCP 2.37 CM	T14REG 523.7 DEG.C
		10 QDISP 14. WATTS	FREQ 30.1 HZ	PDYNDB***** KPA	T15REG 397.9 DEG.C
		11 QREG1 111. WATTS		PDLCLR 3.90 KPA	T16REG 399.7 DEG.C
		12 QREG2 114. WATTS		PDLREG 39.37 KPA	T17REG 387.7 DEG.C
		13 QREG3 35. WATTS		PDLDIS 71.29 KPA	T18REG 382.7 DEG.C
		14 PFP 998.3 KPA/CM			T19REG 246.2 DEG.C
		15 PFD 303.3 KPA/CM			T03HED***** DEG.C
		16 NBEALE 0.00512			

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APPENDIX C. - CONTINUED.

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 08/27/84 13:55:22.27 RDG 1198

FLUID HELIUM BAROM 14.332 PSI REGENERATOR 1 DISPLACER 1 STANDARD PISTON

HEAT TO DASHPOT COOLING		POWER IN	ENGINE CHARGE PRESSURE	GAS TEMPERATURES	SURFACE TEMPERATURES
FLODP	4.01 L/MIN	AMPS1 633. AMPS AMPS2 516. AMPS	PRESUP 7273. KPA	TGEXP 564.3 DEG.C	T01HTR 600.3 DEG.C
WINDP	18.5 DEG.C	VOLTG 2.51 VOLTS	MEANBP 6991. KPA	TGREGH 561.6 DEG.C	T02HTR 607.0 DEG.C
TFDCT	2.05 DEG.C		MEANCP 7027. KPA	TGREGC 118.7 DEG.C	T03HTR 613.9 DEG.C
TWODPR	21.2 DEG.C			TGCOMP 66.2 DEG.C	T04HTR 607.0 DEG.C
				TGBOUN 39.9 DEG.C	T05HTR 618.5 DEG.C
					T06HTR 609.5 DEG.C
					T07HTR 608.2 DEG.C
					T08HTR 580.8 DEG.C
					T09HTR 612.3 DEG.C
HEAT TO COOLER		CALCULATED PARAMETERS	VIBRATION	REMOTE CALCULATIONS	SURFACE TEMPERATURES
FLOCLR	4.14 L/MIN	1 PWRIM 2882. WATTS	VX1HOR 0.5 CM/S	PWRROUT 635. WATTS	T10HTR 588.8 DEG.C
TWINCL	53.8 DEG.C	2 QCOOLR 1646. WATTS	VY1VER 7.2 CM/S	INDPWR 687. WATTS	T11HTR 577.9 DEG.C
TDLCL	5.79 DEG.C	3 QDSHPT 575. WATTS		PISTST 2.21 CM	T12HTR 580.4 DEG.C
TWOCLR	58.75 DEG.C	4 EXTEFF 22.0 %		DISPST 2.08 CM	
		5 TAVHTR 600.4 DEG.C	PADISP 58.8 DEG.		T13REG***** DEG.C
		6 INTEFF 27.9 %	PAPRES -15.8 DEG.		T14REG 524.2 DEG.C
		8 AMPS 1149. AMPS		DYNAMIC CALCULATIONS	T15REG 400.3 DEG.C
		9 QDISPG 3. WATTS	ENGINE SPEED	PAMPC 974. KPA	T16REG 401.8 DEG.C
		10 QDISP 14. WATTS	FREQ 30.1 HZ	DISPPC 2.15 CM	T17REG 389.2 DEG.C
		11 QREG1 108. WATTS		PISTCP 2.39 CM	T18REG 382.9 DEG.C
		12 QREG2 115. WATTS		PDYNDB***** KPA	T19REG 249.6 DEG.C
		13 QREG3 34. WATTS		PDLCLR 4.41 KPA	
		14 PFP 993.0 KPA/CM		PDLREG 44.12 KPA	
		15 PFD 297.3 KPA/CM		PDLDIS 78.06 KPA	T03HED***** DEG.C
		16 NBEALE 0.00531			

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 08/27/84 14:00:22.27 RDG 1199

FLUID HELIUM BAROM 14.332 PSI REGENERATOR 1 DISPLACER 1 STANDARD PISTON

HEAT TO DASHPOT COOLING		POWER IN	ENGINE CHARGE PRESSURE	GAS TEMPERATURES	SURFACE TEMPERATURES
FLODP	4.01 L/MIN	AMPS1 663. AMPS AMPS2 545. AMPS	PRESUP 7294. KPA	TGEXP 561.2 DEG.C	T01HTR 601.4 DEG.C T02HTR 607.2 DEG.C T03HTR 614.5 DEG.C T04HTR 606.8 DEG.C T05HTR 619.1 DEG.C T06HTR 610.8 DEG.C T07HTR 609.4 DEG.C T08HTR 580.6 DEG.C T09HTR 613.5 DEG.C
TWINDP	18.6 DEG.C	VOLTG 2.64 VOLTS	MEANBP 6992. KPA MEANC P 7033. KPA	TGREGH 561.0 DEG.C TGREGC 121.9 DEG.C TGCOMP 69.7 DEG.C TGBOUN 41.7 DEG.C	
TDLDP	2.39 DEG.C				
TWODPR	21.7 DEG.C				
HEAT TO COOLER		CALCULATED PARAMETERS	VIBRATION	REMOTE CALCULATIONS	SURFACE TEMPERATURES
FLOCLR	4.15 L/MIN	1 PWRIN 3188. WATTS	VXIHOR 0.5 CM/S	PWRROUT 702. WATTS	T10HTR 586.9 DEG.C T11HTR 577.6 DEG.C
TWINCL	53.9 DEG.C	2 QCOOLR 1911. WATTS	VY1VER 7.8 CM/S	INDPWR 759. WATTS	T12HTR 577.9 DEG.C
TDICL	6.70 DEG.C	3 QDSHPT 667. WATTS		PISTST 2.40 CM	
TWOCLR	59.60 DEG.C	4 EXTEFF 22.0 %		DISPST 2.17 CM	
		5 TAVHTR 600.5 DEG.C	PADISP 58.9 DEG.		T13REG***** DEG.C
		6 INTEFF 26.9 %	PAPRES -14.6 DEG.	DYNAMIC CALCULATIONS	T14REG 523.7 DEG.C
		8 AMPS 1208. AMPS		PAMFC 1073. KPA	T15REG 402.1 DEG.C
		9 QDISPG 3. WATTS		DISPCCP 2.22 CM	T16REG 405.0 DEG.C
		10 QDISP 14. WATTS	ENGINE SPEED	PISTCP 2.38 CM	T17REG 392.3 DEG.C
		11 QREG1 106. WATTS	FREQ 30.2 HZ	PDYNDR***** KPA	T18PEG 383.3 DEG.C
		12 QREG2 114. WATTS		PDLCLR 5.09 KPA	T19PEG 252.8 DEG.C
		13 QREG3 34. WATTS		PDLREG 48.53 KPA	
		14 PFP 1001.2 KPA/CM		PDLDIS 84.51 KPA	T03HED***** DEG.C
		15 PFD 291.6 KPA/CM			
		16 NBEALE 0.00540			

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 08/27/84 14:05:40.27 RDG 1200

FLUID HELIUM BAROM 14.332 PSI REGENERATOR 1 DISPLACER 1 STANDARD PISTON

HEAT TO DASHPOT COOLING		POWER IN	ENGINE CHARGE PRESSURE	GAS TEMPERATURES	SURFACE TEMPERATURES
FLODP	4.01 L/MIN	AMPS1 694. AMPS AMPS2 569. AMPS VOLTG 7 VOLTS	PRESUP 7311. KPA MEANBP 6986. KPA MEANCP 7031. KPA	TGEXP 558.0 DEG.C TGREGH 558.6 DEG.C TGREGC 123.0 DEG.C TGCOMP 74.7 DEG.C TGBOUN 43.1 DEG.C	T01HTR 600.3 DEG.C T02HTR 607.1 DEG.C T03HTR 614.6 DEG.C T04HTR 605.0 DEG.C T05HTR 619.5 DEG.C T06HTR 611.7 DEG.C T07HTR 610.3 DEG.C T08HTR 578.4 DEG.C T09HTR 612.6 DEG.C T10HTR 584.7 DEG.C T11HTR 575.1 DEG.C T12HTR 575.6 DEG.C
TWINDP	18.7 DEG.C				
TDLDP	2.63 DEG.C				
TWODPR	22.1 DEG.C				

HEAT TO COOLER		CALCULATED PARAMETERS	VIBRATION	REMOTE CALCULATIONS	SURFACE TEMPERATURES
FLOC LR	4.15 L/MIN	1 PWRIN 3493. WATTS	VX1HOR 0.6 CM/S	PWRROUT 777. WATTS	T10HTR 584.7 DEG.C
TWINCL	54.0 DEG.C	2 QCOOLR 2108. WATTS	VY1VER 8.4 CM/S	INDPWR 837. WATTS	T11HTR 575.1 DEG.C
TDLCL	7.39 DEG.C	3 QDSHPT 734. WATTS		PISTST 2.60 CM	T12HTR 575.6 DEG.C
TWOCLR	60.48 DEG.C	4 EXTEFF 22.2 %		DISPST 2.29 CM	
		5 TAVHTR 599.6 DEG.C	PADISP 59.1 DEG.		T13REG***** DEG.C
		6 INTEFF 26.9 %	PAPRES -13.7 DEG.		T14REG 522.7 DEG.C
		8 AMPS 1263. AMPS		DYNAMIC CALCULATIONS	T15REG 402.6 DEG.C
		9 QDISPG 3. WATTS		PAMPC 1161. KPA	T16REG 402.4 DEG.C
		10 QDISP 14. WATTS		DISPPCP 2.25 CM	T17REG 388.9 DEG.C
		11 QREG1 103. WATTS	ENGINE SPEED	PISTCP 2.34 CM	T18REG 382.4 DEG.C
		12 QREG2 114. WATTS	FREQ 30.2 HZ	PDYNDB***** KPA	T19REG 255.2 DEG.C
		13 QREG3 34. WATTS		PDLCLR 6.11 KPA	
		14 PFP 994.2 KPA/CM		PDLREG 53.29 KPA	
		15 PFD 280.7 KPA/CM		PDLDIS 91.98 KPA	T03HED***** DEG.C
		16 NREALE 0.00551			

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APPENDIX C. - CONTINUED.

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 08/27/84 14:10:19.27 RDG 1201

FLUID HELIUM BAROM 14.332 PSI REGENERATOR 1 DISPLACER 1 STANDARD PISTON

HEAT TO DASHPOT COOLING		POWER IN	ENGINE CHARGE PRESSURE	GAS TEMPERATURES	SURFACE TEMPERATURES
FLODP	4.01 L/MIN	AMPS1 723. AMPS	PRESUP 7305. KPA	TGEXP 556.4 DEG.C	T01HTR 602.6 DEG.C
		AMPS2 598. AMPS			T02HTR 608.4 DEG.C
TWINDP	18.9 DEG.C	VOLTG 2.89 VOLTS	MEANBP 6991. KPA	TGREGH 557.1 DEG.C	T03HTR 617.3 DEG.C
TDLDP	2.99 DEG.C		MEANCP 7039. KPA	TGREGC 120.6 DEG.C	T04HTR 604.0 DEG.C
TWODPR	22.5 DEG.C			TGCOMP 76.3 DEG.C	T05HTR 623.0 DEG.C
				TGBOUN 44.5 DEG.C	T06HTR 612.7 DEG.C
					T07HTR 611.5 DEG.C
					T08HTR 579.8 DEG.C
					T09HTR 612.4 DEG.C
					T10HTR 585.8 DEG.C
					T11HTR 574.0 DEG.C
					T12HTR 576.0 DEG.C
HEAT TO COOLER		CALCULATED PARAMETERS	VIBRATION	REMOTE CALCULATIONS	
FLOCRL	4.14 L/MIN	1 PWRIN 3821. WATTS	VX1HOR 0.6 CM/S	PWRROUT 867. WATTS	
TWINCL	53.9 DEG.C	2 QCoolR 2429. WATTS	VY1VER 9.1 CM/S	INDPWR 926. WATTS	
TDLCL	8.53 DEG.C	3 QDSHPT 835. WATTS		PISTST 2.79 CM	
TWOCLR	61.33 DEG.C	4 EXTEFF 22.7 %	PHASE ANGLES	DISPST 2.42 CM	
		5 TAVHTR 600.6 DEG.C	PADISP 59.0 DEG.		T13REG***** DEG.C
		6 INTEFF 26.3 %	PAPRES -13.1 DEG.		T14REG 518.9 DEG.C
		8 AMPS 1321. AMPS		DYNAMIC CALCULATIONS	
		9 QDISPG 3. WATTS	ENGINE SPEED	PAMPC 1260. KPA	T15REG 389.9 DEG.C
		10 QDISP 14. WATTS	FREQ 30.3 HZ	DISFCP 2.30 CM	T16REG 385.9 DEG.C
		11 QREG1 103. WATTS		PISTCP 2.27 CM	T17REG 377.6 DEG.C
		12 QREG2 119. WATTS		PDYNDB***** KPA	T18REG 372.5 DEG.C
		13 QREG3 34. WATTS		PDLCLR 7.13 KPA	T19REG 245.5 DEG.C
		14 PFP 1001.2 KPA/CM		PDLREG 58.38 KPA	
		15 PFD 274.5 KPA/CM		PDLDIS100.12 KPA	
		16 NBEALE 0.00571			T03HED***** DEG.C

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 08/27/84 14:15:34.27 RDG 1202

FLUID HELIUM BAROM 14.327 PSI REGENERATOR 1 DISPLACER 1 STANDARD PISTON

HEAT TO DASHPOT COOLING		POWER IN	ENGINE CHARGE PRESSURE	GAS TEMPERATURES	SURFACE TEMPERATURES
FLODP	4.02 L/MIN	AMPS1 783. AMPS	PRESUP 7280. KPA	TGEXP 552.0 DEG.C	T01HTR 602.5 DEG.C
		AMPS2 647. AMPS			T02HTR 612.2 DEG.C
TWINDP	19.0 DEG.C	VOLTG 3.13 VOLTS	MEANBP 6995. KPA	TGREGH 546.6 DEG.C	T03HTR 617.6 DEG.C
TDLDP	3.29 DEG.C		MEANCP 7050. KPA	TGREGC 115.6 DEG.C	T04HTR 603.5 DEG.C
TWODPR	22.9 DEG.C			TGCOMP 88.7 DEG.C	T05HTR 624.6 DEG.C
				TGBOUN 46.0 DEG.C	T06HTR 614.3 DEG.C
					T07HTR 612.8 DEG.C
					T08HTR 578.2 DEG.C
					T09HTR 610.6 DEG.C
HEAT TO COOLER		CALCULATED PARAMETERS	VIBRATION	REMOTE CALCULATIONS	
FLOCRL	4.16 L/MIN	1 PWRIN 4480. WATTS	VX1HOR 0.6 CM/S	PWRROUT 939. WATTS	T10HTR 586.3 DEG.C
TWINCL	54.1 DEG.C	2 QCoolR 2878. WATTS	VY1VER 9.7 CM/S	INDPWR 978. WATTS	T11HTR 569.6 DEG.C
TDLCL	10.06 DEG.C	3 QDSHPT 920. WATTS		PISTST 2.99 CM	T12HTR 577.0 DEG.C
TWOCLR	63.05 DEG.C	4 EXTEFF 21.0 %	PHASE ANGLES	DISPST 2.41 CM	
		5 TAVHTR 600.8 DEG.C	PADISP 59.5 DEG.		T13REG***** DEG.C
		6 INTEFF 24.6 %	PAPRES -11.6 DEG.		T14REG 496.1 DEG.C
		8 AMPS 1430. AMPS		DYNAMIC CALCULATIONS	
		9 QDISPG 3. WATTS	ENGINE SPEED	PAMPC 1358. KPA	T15REG 341.2 DEG.C
		10 QDISP 13. WATTS	FREQ 30.3 HZ	DISFCP 2.40 CM	T16REG 338.3 DEG.C
		11 QREG1 90. WATTS		PISTCP 2.16 CM	T17REG 331.2 DEG.C
		12 QREG2 141. WATTS		PDYNDB***** KPA	T18REG 322.7 DEG.C
		13 QREG3 33. WATTS		PDLCLR***** KPA	T19REG 211.5 DEG.C
		14 PFP 995.9 KPA/CM		PDLREG 59.73 KPA	
		15 PFD 262.4 KPA/CM		PDLDIS104.87 KPA	
		16 NBEALE 0.00576			T03HED***** DEG.C

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 09/26/84 10:34:29.52 RDG 1353

FLUID HELIUM BAROM 14.474 PSI REGENERATOR 1 DISPLACER 2 STANDARD PISTON

HEAT TO DASHPOT COOLING		POWER IN	ENGINE CHARGE PRESSURE	GAS TEMPERATURES	SURFACE TEMPERATURES
FLODP	4.44 L/MIN	AMPS1 553. AMPS	PRESUP 7180. KPA	TGEXP 570.0 DEG.C	T01HTR 595.9 DEG.C
		AMPS2 485. AMPS			T02HTR 614.9 DEG.C
TWINDP	18.9 DEG.C	VOLTG 2.24 VOLTS	MEANBP 7016. KPA	TGREGH 554.2 DEG.C	T03HTR 605.8 DEG.C
TDLDP	1.14 DEG.C		MEANCP 7044. KPA	TGREGC 90.3 DEG.C	T04HTR 611.3 DEG.C
TWODPR	20.7 DEG.C			TGCOMP 41.5 DEG.C	T05HTR 611.4 DEG.C
				TGBOUN 33.6 DEG.C	T06HTR 607.4 DEG.C
					T07HTR 606.7 DEG.C
					T08HTR 577.0 DEG.C
					T09HTR 607.6 DEG.C
HEAT TO COOLER		CALCULATED PARAMETERS	VIBRATION	REMOTE CALCULATIONS	
FLOCRL	4.20 L/MIN	1 PWRIN 2329. WATTS	VX1HOR 0.5 CM/S	PWRROUT 486. WATTS	T10HTR 592.4 DEG.C
TWINCL	25.1 DEG.C	2 QCoolR 1795. WATTS	VY1VER 6.3 CM/S	INDPWR 504. WATTS	T11HTR 576.1 DEG.C
TDLCL	6.16 DEG.C	3 QDSHPT 352. WATTS		PISTST 1.80 CM	T12HTR 588.5 DEG.C
TWOCLR	30.00 DEG.C	4 EXTEFF 20.9 %	PHASE ANGLES	DISPST 1.46 CM	
		5 TAVHTR 599.6 DEG.C	PADISP 75.8 DEG.		T13REG***** DEG.C
		6 INTEFF 21.3 %	PAPRES -14.6 DEG.		T14REG 512.8 DEG.C
		8 AMPS 1038. AMPS		DYNAMIC CALCULATIONS	
		9 QDISPG 3. WATTS	ENGINE SPEED	PAMPC 896. KPA	T15REG 379.1 DEG.C
		10 QDISP 15. WATTS	FREQ 31.4 HZ	DISFCP 2.54 CM	T16REG 384.1 DEG.C
		11 QREG1 108. WATTS		PISTCP 2.28 CM	T17REG 369.9 DEG.C
		12 QREG2 128. WATTS		PDYNDB 863. KPA	T18REG 354.5 DEG.C
		13 QREG3 36. WATTS		PDLCLR 4.24 KPA	T19REG 221.1 DEG.C
		14 PFP 1024.5 KPA/CM		PDLREG 33.60 KPA	
		15 PFD 318.6 KPA/CM		PDLDIS 61.09 KPA	
		16 NBEALE 0.00476			T03HED***** DEG.C

OPTIONAL FORM 18
OF FORM 18A

APPENDIX C. - CONTINUED.

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 09/26/84 10:39:20.52 RDG 1354

FLUID HELIUM BAROM 14.474 PSI REGENERATOR 1 DISPLACER 2 STANDARD PISTON

HEAT TO DASHPOT COOLING		POWER IN	ENGINE CHARGE PRESSURE	GAS TEMPERATURES	SURFACE TEMPERATURES
FLODP	4.42 L/MIN	AMPS1 589. AMPS	PRESUP 7176. KPA	TGEXP 567.5 DEG.C	T01HTR 599.0 DEG.C
		AMPS2 517. AMPS			T02HTR 614.7 DEG.C
TWINDP	18.8 DEG.C	VOLTG 2.39 VOLTS	MEANBP 7013. KPA	TGREGH 555.3 DEG.C	T03HTR 608.7 DEG.C
TDLDP	1.29 DEG.C		MEANCP 7046. KPA	TGREGC 92.9 DEG.C	T04HTR 610.9 DEG.C
TWODPR	20.9 DEG.C			TGCOMP 44.3 DEG.C	T05HTR 613.6 DEG.C
				TGBOUN 33.8 DEG.C	T06HTR 608.5 DEG.C

HEAT TO COOLER		CALCULATED PARAMETERS	VIBRATION	REMOTE CALCULATIONS	SURFACE TEMPERATURES
FLOCRL	4.19 L/MIN	1 PWRIN 2649. WATTS	VX1HOR 0.5 CM/S	PWRROUT 570. WATTS	T10HTR 592.5 DEG.C
TWINCL	25.0 DEG.C	2 QCQLR 1999. WATTS	VY1VER 7.0 CM/S	INDPWR 590. WATTS	T11HTR 576.9 DEG.C
TDLCL	6.88 DEG.C	3 QDSHPT 396. WATTS		PISTST 2.00 CM	T12HTR 586.7 DEG.C
TWOCLR	30.79 DEG.C	4 EXTEFF 21.5 %		DISPST 1.58 CM	
		5 TAVHTR 600.6 DEG.C	PHASE ANGLES		T13REG***** DEG.C
		6 INTEFF 22.2 %	PADISP 76.9 DEG.	DYNAMIC CALCULATIONS	T14REG 513.0 DEG.C
		8 AMPS 1106. AMPS	PAPRES -13.8 DEG.	PAMPC 994. KPA	T15REG 381.2 DEG.C
		9 QDISPG 3. WATTS		DISPCP 2.56 CM	T16REG 385.9 DEG.C
		10 QDISP 15. WATTS	ENGINE SPEED	PISTCP 2.29 CM	T17REG 375.8 DEG.C
		11 QREG1 109. WATTS	FREQ 31.5 HZ	PDINDB 938. KPA	T18REG 359.7 DEG.C
		12 QREG2 124. WATTS		PDLCLR 5.09 KPA	T19REG 224.8 DEG.C
		13 QREG3 36. WATTS		PDLREG 39.03 KPA	
		14 PFP 1020.2 KPA/CM		PDLDIS 70.26 KPA	T03HED***** DEG.C
		15 PFD 309.4 KPA/CM			
		16 NBEALE 0.00503			

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 09/26/84 10:44:41.52 RDG 1355

FLUID HELIUM BAROM 14.474 PSI REGENERATOR 1 DISPLACER 2 STANDARD PISTON

HEAT TO DASHPOT COOLING		POWER IN	ENGINE CHARGE PRESSURE	GAS TEMPERATURES	SURFACE TEMPERATURES
FLODP	4.42 L/MIN	AMPS1 630. AMPS	PRESUP 7179. KPA	TGEXP 565.0 DEG.C	T01HTR 599.9 DEG.C
		AMPS2 546. AMPS			T02HTR 614.3 DEG.C
TWINDP	18.8 DEG.C	VOLTG 2.54 VOLTS	MEANBP 7002. KPA	TGREGH 554.0 DEG.C	T03HTR 610.2 DEG.C
TDLDP	1.56 DEG.C		MEANCP 7038. KPA	TGREGC 94.7 DEG.C	T04HTR 609.3 DEG.C
TWODPR	21.1 DEG.C			TGCOMP 46.4 DEG.C	T05HTR 615.5 DEG.C
				TGBOUN 34.4 DEG.C	T06HTR 609.3 DEG.C

HEAT TO COOLER		CALCULATED PARAMETERS	VIBRATION	REMOTE CALCULATIONS	SURFACE TEMPERATURES
FLOCRL	4.21 L/MIN	1 PWRIN 2988. WATTS	VX1HOR 0.6 CM/S	PWRROUT 665. WATTS	T10HTR 591.2 DEG.C
TWINCL	25.0 DEG.C	2 QCQLR 2231. WATTS	VY1VER 7.6 CM/S	INDPWR 688. WATTS	T11HTR 575.1 DEG.C
TDLCL	7.64 DEG.C	3 QDSHPT 478. WATTS		PISTST 2.20 CM	T12HTR 584.7 DEG.C
TWOCLR	31.41 DEG.C	4 EXTEFF 22.2 %		DISPST 1.70 CM	
		5 TAVHTR 600.5 DEG.C	PHASE ANGLES		T13REG***** DEG.C
		6 INTEFF 23.0 %	PADISP 78.3 DEG.	DYNAMIC CALCULATIONS	T14REG 514.0 DEG.C
		8 AMPS 1175. AMPS	PAPRES -13.3 DEG.	PAMPC 1107. KPA	T15REG 385.7 DEG.C
		9 QDISPG 3. WATTS		DISPCP 2.66 CM	T16REG 386.1 DEG.C
		10 QDISP 15. WATTS	ENGINE SPEED	PISTCP 2.31 CM	T17REG 377.2 DEG.C
		11 QREG1 108. WATTS	FREQ 31.5 HZ	PDYNDB 1013. KPA	T18REG 362.9 DEG.C
		12 QREG2 123. WATTS		PDLCLR 6.11 KPA	T19REG 230.2 DEG.C
		13 QREG3 36. WATTS		PDLPEG 47.52 KPA	
		14 PFP 1026.0 KPA/CM		PDLDIS 84.17 KPA	T03HED***** DEG.C
		15 PFD 306.8 KPA/CM			
		16 NBEALE 0.00532			

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 09/26/84 10:49:20.52 RDG 1356

FLUID HELIUM BAROM 14.474 PSI REGENERATOR 1 DISPLACER 2 STANDARD PISTON

HEAT TO DASHPOT COOLING		POWER IN	ENGINE CHARGE PRESSURE	GAS TEMPERATURES	SURFACE TEMPERATURES
FLODP	4.41 L/MIN	AMPS1 651. AMPS	PRESUP 7174. KPA	TGEXP 562.0 DEG.C	T01HTR 600.8 DEG.C
		AMPS2 578. AMPS			T02HTR 613.9 DEG.C
TWINDP	18.8 DEG.C	VOLTG 2.66 VOLTS	MEANBP 6993. KPA	TGREGH 552.7 DEG.C	T03HTR 611.7 DEG.C
TDLDP	1.83 DEG.C		MEANCP 7034. KPA	TGREGC 96.7 DEG.C	T04HTR 608.2 DEG.C
TWODPR	21.2 DEG.C			TGCOMP 49.0 DEG.C	T05HTR 617.1 DEG.C
				TGBOUN 35.1 DEG.C	T06HTR 610.3 DEG.C

HEAT TO COOLER		CALCULATED PARAMETERS	VIBRATION	REMOTE CALCULATIONS	SURFACE TEMPERATURES
FLOCRL	4.20 L/MIN	1 PWRIN 3269. WATTS	VX1HOR 0.6 CM/S	PWRROUT 737. WATTS	T10HTR 590.1 DEG.C
TWINCL	25.1 DEG.C	2 QCQLR 2347. WATTS	VY1VER 8.3 CM/S	INDPWR 758. WATTS	T11HTR 574.1 DEG.C
TDLCL	8.05 DEG.C	3 QDSHPT 562. WATTS		PISTST 2.41 CM	T12HTR 583.3 DEG.C
TWOCLR	32.04 DEG.C	4 EXTEFF 22.5 %		DISPST 1.79 CM	
		5 TAVHTR 600.6 DEG.C	PHASE ANGLES		T13REG***** DEG.C
		6 INTEFF 23.9 %	PADISP 77.6 DEG.	DYNAMIC CALCULATIONS	T14REG 513.8 DEG.C
		8 AMPS 1229. AMPS	PAPRES -12.3 DEG.	PAMPC 1191. KPA	T15REG 386.6 DEG.C
		9 QDISPG 3. WATTS		DISPCP 2.70 CM	T16REG 386.8 DEG.C
		10 QDISP 15. WATTS	ENGINE SPEED	PISTCP 2.32 CM	T17REG 378.8 DEG.C
		11 QREG1 108. WATTS	FREQ 31.3 HZ	PDYNDB 1113. KPA	T18REG 364.8 DEG.C
		12 QREG2 121. WATTS		PDLCLR 6.96 KPA	T19REG 232.2 DEG.C
		13 QREG3 35. WATTS		PDLREG 50.57 KPA	
		14 PFP 1013.0 KPA/CM		PDLDIS 88.92 KPA	T03HED***** DEG.C
		15 PFD 289.6 KPA/CM			
		16 NBEALE 0.00544			

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APPENDIX C. - CONTINUED.

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 09/26/84 10:54:20.52 RDG 1357

FLUID HELIUM		BAROM 14.474 PSI REGENERATOR 1 DISPLACER 2 STANDARD PISTON			
HEAT TO DASHPOT COOLING	FLODP 4.38 L/MIN	POWER IN	ENGINE CHARGE PRESSURE	GAS TEMPERATURES	SURFACE TEMPERATURES
		AMPS1 680. AMPS	PRESUP 7163. KPA	TGEXP 559.5 DEG.C	T01HTR 601.7 DEG.C
		AMPS2 605. AMPS			T02HTR 614.3 DEG.C
TWINDP 18.8 DEG.C		VOLTG 2.78 VOLTS	MEANBP 6992. KPA	TGREGH 551.9 DEG.C	T03HTR 612.7 DEG.C
TDLDP 1.99 DEG.C			MEANCP 7033. KPA	TGREGC 98.6 DEG.C	T04HTR 608.1 DEG.C
TWODPR 21.4 DEG.C				TGCOMP 51.6 DEG.C	T05HTR 618.4 DEG.C
				TGBOUN 35.8 DEG.C	T06HTR 611.3 DEG.C
					T07HTR 610.5 DEG.C
					T08HTR 578.3 DEG.C
					T09HTR 610.9 DEG.C
HEAT TO COOLER	FLOCRL 4.22 L/MIN	CALCULATED PARAMETERS	VIBRATION	REMOTE CALCULATIONS	T10HTR 589.1 DEG.C
		1 PWRIN 3575. WATTS	VX1HOR 0.7 CM/S	PWRROUT 798. WATTS	T11HTR 573.5 DEG.C
		2 QCOOLR 2563. WATTS	VY1VER 8.9 CM/S	INDPWR 818. WATTS	T12HTR 582.0 DEG.C
TWINCL 25.0 DEG.C		3 QDSHPT 605. WATTS		PISTST 2.61 CM	
TDLCL 8.75 DEG.C		4 EXTEFF 22.3 %	PHASE ANGLES	DISPST 1.88 CM	
TWOCLR 32.75 DEG.C		5 TAVHTR 600.9 DEG.C	PADISP 77.7 DEG.		T13REG***** DEG.C
		6 INTEFF 23.7 %	PAPRES -11.3 DEG.		T14REG 514.2 DEG.C
		8 AMPS 1285. AMPS		DYNAMIC CALCULATIONS	T15REG 390.1 DEG.C
		9 QDISPG 3. WATTS	ENGINE SPEED	PAMPC 1299. KPA	T16REG 386.3 DEG.C
		10 QDISP 14. WATTS	FREQ 31.3 HZ	DISPCP 2.65 CM	T17REG 378.5 DEG.C
		11 QREG1 103. WATTS		PISTCP 2.36 CM	T18REG 364.0 DEG.C
		12 QREG2 122. WATTS		PDYNDB 1163. KPA	T19REG 237.4 DEG.C
		13 QREG3 35. WATTS		PDLCLR 7.81 KPA	
		14 PFP 1020.3 KPA/CM		PDLREG 57.36 KPA	
		15 PFD 277.8 KPA/CM		PDLDIS 99.10 KPA	
		16 NBEALE 0.00545			T03HED***** DEG.C

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 09/26/84 10:59:38.52 RDG 1358

FLUID HELIUM		BAROM 14.474 PSI REGENERATOR 1 DISPLACER 2 STANDARD PISTON			
HEAT TO DASHPOT COOLING	FLODP 4.36 L/MIN	POWER IN	ENGINE CHARGE PRESSURE	GAS TEMPERATURES	SURFACE TEMPERATURES
		AMPS1 711. AMPS	PRESUP 7175. KPA	TGEXP 556.8 DEG.C	T01HTR 601.8 DEG.C
		AMPS2 630. AMPS			T02HTR 614.1 DEG.C
TWINDP 18.7 DEG.C		VOLTG 2.90 VOLTS	MEANBP 7019. KPA	TGREGH 550.4 DEG.C	T03HTR 613.3 DEG.C
TDLDP 2.25 DEG.C			MEANCP 7064. KPA	TGREGC 101.1 DEG.C	T04HTR 607.2 DEG.C
TWODPR 21.6 DEG.C				TGCOMP 55.2 DEG.C	T05HTR 619.1 DEG.C
				TGBOUN 37.0 DEG.C	T06HTR 612.3 DEG.C
					T07HTR 611.6 DEG.C
					T08HTR 577.5 DEG.C
HEAT TO COOLER	FLOCRL 4.22 L/MIN	CALCULATED PARAMETERS	VIBRATION	REMOTE CALCULATIONS	T09HTR 611.3 DEG.C
		1 PWRIN 3891. WATTS	VX1HOR 0.7 CM/S	PWRROUT 870. WATTS	T10HTR 587.4 DEG.C
		2 QCOOLR 2795. WATTS	VY1VER 9.5 CM/S	INDPWR 887. WATTS	T11HTR 572.3 DEG.C
TWINCL 25.0 DEG.C		3 QDSHPT 684. WATTS		PISTST 2.79 CM	T12HTR 579.8 DEG.C
TDLCL 9.55 DEG.C		4 EXTEFF 22.4 %	PHASE ANGLES	DISPST 1.96 CM	
TWOCLR 33.62 DEG.C		5 TAVHTR 600.6 DEG.C	PADISP 78.1 DEG.		T13REG***** DEG.C
		6 INTEFF 23.7 %	PAPRES -10.9 DEG.		T14REG 513.4 DEG.C
		8 AMPS 1341. AMPS		DYNAMIC CALCULATIONS	T15REG 390.1 DEG.C
		9 QDISPG 3. WATTS	ENGINE SPEED	PAMPC 1383. KPA	T16REG 387.2 DEG.C
		10 QDISP 14. WATTS	FREQ 31.3 HZ	DISPCP 2.74 CM	T17REG 378.5 DEG.C
		11 QPEG1 101. WATTS		PISTCP 2.33 CM	T18REG 363.7 DEG.C
		12 QREG2 121. WATTS		PDYNDB 1250. KPA	T19REG 239.1 DEG.C
		13 QPEG3 35. WATTS		PDLCLR 8.65 KPA	
		14 PFP 1011.9 KPA/CM		PDLREG 61.43 KPA	
		15 PFD 271.3 KPA/CM		PDLDIS 104.87 KPA	
		16 NBEALE 0.00553			T03HED***** DEG.C

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 09/26/84 13:52:29.52 RDG 1359

FLUID HELIUM		BAROM 14.489 PSI REGENERATOR 1 DISPLACER 2 STANDARD PISTON			
HEAT TO DASHPOT COOLING	FLODP 4.04 L/MIN	POWER IN	ENGINE CHARGE PRESSURE	GAS TEMPERATURES	SURFACE TEMPERATURES
		AMPS1 765. AMPS	PRESUP 7172. KPA	TGEXP 552.7 DEG.C	T01HTR 602.9 DEG.C
		AMPS2 648. AMPS			T02HTR 612.8 DEG.C
TWINDP 18.8 DEG.C		VOLTG 3.05 VOLTS	MEANBP 7019. KPA	TGREGH 548.5 DEG.C	T03HTR 615.7 DEG.C
TDLDP 2.33 DEG.C			MEANCP 7072. KPA	TGREGC 98.1 DEG.C	T04HTR 604.7 DEG.C
TWODPR 21.7 DEG.C				TGCOMP 56.8 DEG.C	T05HTR 621.4 DEG.C
				TGBOUN 34.0 DEG.C	T06HTR 611.1 DEG.C
					T07HTR 610.0 DEG.C
					T08HTR 577.6 DEG.C
HEAT TO COOLER	FLOCRL 4.22 L/MIN	CALCULATED PARAMETERS	VIBRATION	REMOTE CALCULATIONS	T09HTR 609.8 DEG.C
		1 PWRIN 4315. WATTS	VX1HOR 0.8 CM/S	PWRROUT 928. WATTS	T10HTR 587.0 DEG.C
		2 QCOOLR 3040. WATTS	VY1VER 10.3 CM/S	INDPWR 945. WATTS	T11HTR 570.0 DEG.C
TWINCL 24.8 DEG.C		3 QDSHPT 656. WATTS		PISTST 3.00 CM	T12HTR 577.7 DEG.C
TDLCL 10.38 DEG.C		4 EXTEFF 21.5 %	PHASE ANGLES	DISPST 2.05 CM	
TWOCLR 34.04 DEG.C		5 TAVHTR 600.1 DEG.C	PADISP 78.0 DEG.		T13REG***** DEG.C
		6 INTEFF 23.4 %	PAPRES -10.0 DEG.		T14REG 511.7 DEG.C
		8 AMPS 1413. AMPS		DYNAMIC CALCULATIONS	T15REG 389.4 DEG.C
		9 QDISPG 3. WATTS	ENGINE SPEED	PAMPC 1506. KPA	T16REG 383.5 DEG.C
		10 QDISP 14. WATTS	FREQ 31.2 HZ	DISPCP 2.82 CM	T17REG 380.1 DEG.C
		11 QREG1 106. WATTS		PISTCP 2.34 CM	T18REG 371.1 DEG.C
		12 QREG2 114. WATTS		PDYNDB 1313. KPA	T19REG 240.3 DEG.C
		13 QREG3 35. WATTS		PDLCLR 11.20 KPA	
		14 PFP 1026.1 KPA/CM		PDLREG 69.58 KPA	
		15 PFD 260.8 KPA/CM		PDLDIS 117.77 KPA	
		16 NBEALE 0.00550			T03HED***** DEG.C

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APPENDIX C. - CONTINUED.

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 09/26/84 13:58:08.52 RDG 1360

FLUID HELIUM BAROM 14.489 PSI REGENERATOR 1 DISPLACER 2 STANDARD PISTON

HEAT TO DASHPOT COOLING	POWER IN	ENGINE CHARGE PRESSURE	GAS TEMPERATURES	SURFACE TEMPERATURES
FLODP 4.06 L/MIN	AMPS1 785. AMPS	PRESUP 7033. KPA	TGEXP 551.0 DEG.C	T01HTR 603.1 DEG.C
	AMPS2 675. AMPS			T02HTR 612.7 DEG.C
TWINDP 18.8 DEG.C	VOLTG 3.16 VOLTS	MEANBP 6982. KPA	TGREGH 547.3 DEG.C	T03HTR 616.4 DEG.C
TDLDP 2.74 DEG.C		MEANCP 7038. KPA	TGREGC 100.3 DEG.C	T04HTR 603.8 DEG.C
TWODPR 22.0 DEG.C			TGCOMP 60.3 DEG.C	T05HTR 622.6 DEG.C
			TGBOUN 36.7 DEG.C	T06HTR 612.2 DEG.C
				T07HTR 611.7 DEG.C
				T08HTR 576.9 DEG.C
				T09HTR 610.3 DEG.C
				T10HTR 585.6 DEG.C
				T11HTR 569.1 DEG.C
				T12HTR 576.1 DEG.C
				T13REG***** DEG.C
				T14REG 511.8 DEG.C
				T15REG 390.4 DEG.C
				T16REG 383.8 DEG.C
				T17REG 380.3 DEG.C
				T18REG 371.0 DEG.C
				T19REG 242.4 DEG.C
				T03HED***** DEG.C
HEAT TO COOLER	CALCULATED PARAMETERS	VIBRATION	REMOTE CALCULATIONS	
FLOCLR 4.22 L/MIN	1 PWRIN 4609. WATTS	VX1HOR 0.8 CM/S	PWRROUT 987. WATTS	
TWINCL 24.7 DEG.C	2 QCOOLR 3285. WATTS	VY1VER11.0 CM/S	INDPWR 1000. WATTS	
TDLCL 11.22 DEG.C	3 QDSHPT 774. WATTS		PISTST 3.21 CM	
TWOCLR 34.76 DEG.C	4 EXTEFF 21.4 %		DISPST 2.13 CM	
	5 TAVHTR 600.0 DEG.C	PHASE ANGLES	DYNAMIC CALCULATIONS	
	6 INTEFF 23.1 %	PADISP 77.9 DEG.	PAMPC 1609. KPA	
	8 AMPS 1460. AMPS	PAPRES -9.2 DEG.	DISPCP 2.91 CM	
	9 QDISPG 3. WATTS	ENGINE SPEED	PISTCP 2.36 CM	
	10 QDISP 14. WATTS	FREQ 31.1 Hz	PDYNDB 1350. KPA	
	11 QFEG1 104. WATTS		PDLCLR 11.71 KPA	
	12 QREG2 114. WATTS		PDLREG 77.04 KPA	
	13 QREG3 35. WATTS		PDLDIS128.29 KPA	
	14 PFP 1024.3 KPA/CM			
	15 PFD 247.1 KPA/CM			
	16 NBEALE 0.00552			

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 11/27/84 10:36:18.08 RDG 1548

FLUID NITROGEN BAROM 14.362 PSI REGENERATOR 1 DISPLACER 1 STANDARD PISTON

HEAT TO DASHPOT COOLING	POWER IN	ENGINE CHARGE PRESSURE	GAS TEMPERATURES	SURFACE TEMPERATURES
FLODP 4.01 L/MIN	AMPS1 477. AMPS	PRESUP 7146. KPA	TGEXP 569.6 DEG.C	T01HTR 600.9 DEG.C
	AMPS2 373. AMPS			T02HTR 615.3 DEG.C
TWINDP 19.7 DEG.C	VOLTG 1.88 VOLTS	MEANBP 7003. KPA	TGREGH 552.4 DEG.C	T03HTR 601.6 DEG.C
TDLDP 0.73 DEG.C		MEANCP 7041. KPA	TGREGC 103.0 DEG.C	T04HTR 619.8 DEG.C
TWODPR 20.6 DEG.C			TGCOMP 35.5 DEG.C	T05HTR 599.1 DEG.C
			TGBOUN 25.2 DEG.C	T06HTR 602.4 DEG.C
				T07HTR 601.6 DEG.C
				T08HTR 585.8 DEG.C
				T09HTR 606.8 DEG.C
				T10HTR 600.9 DEG.C
				T11HTR 582.9 DEG.C
				T12HTR 586.5 DEG.C
HEAT TO COOLER	CALCULATED PARAMETERS	VIBRATION	REMOTE CALCULATIONS	
FLOCLR 4.32 L/MIN	1 PWRIN 1600. WATTS	VX1HOR 0.4 CM/S	PWRROUT 180. WATTS	
TWINCL 25.0 DEG.C	2 QCOOLR 1426. WATTS	VY1VER 4.8 CM/S	INDPWR 194. WATTS	
TDLCL 4.76 DEG.C	3 QDSHPT 203. WATTS		PISTST 1.78 CM	
TWOCLR 28.40 DEG.C	4 EXTEFF 11.3 %		DISPST 1.19 CM	
	5 TAVHTR 600.3 DEG.C	PHASE ANGLES	DYNAMIC CALCULATIONS	
	6 INTEFF 11.2 %	PADISP 39.3 DEG.	PAMPC 753. KPA	
	8 AMPS 850. AMPS	PAPRES -7.0 DEG.	DISPCP 2.18 CM	
	9 QDISPG 0. WATTS	ENGINE SPEED	PISTCP 2.28 CM	
	10 QDISP 15. WATTS	FREQ 27.9 Hz	PDYNDB***** KPA	
	11 QREG1 119. WATTS		T18REG 369.5 DEG.C	
	12 QREG2 97. WATTS		T19REG 223.2 DEG.C	
	13 QREG3 35. WATTS		PDLCLR 8.49 KPA	
	14 PFP 965.8 KPA/CM		PDLREG 40.73 KPA	
	15 PFD 245.8 KPA/CM		PDLDIS109.29 KPA	
	16 NBEALE 0.00202			T03HED***** DEG.C

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 11/27/84 10:41:21.08 RDG 1549

FLUID NITROGEN BAROM 14.357 PSI REGENERATOR 1 DISPLACER 1 STANDARD PISTON

HEAT TO DASHPOT COOLING	POWER IN	ENGINE CHARGE PRESSURE	GAS TEMPERATURES	SURFACE TEMPERATURES
FLODP 4.01 L/MIN	AMPS1 502. AMPS	PRESUP 7143. KPA	TGEXP 570.0 DEG.C	T01HTR 600.6 DEG.C
	AMPS2 389. AMPS			T02HTR 615.5 DEG.C
TWINDP 19.5 DEG.C	VOLTG 1.96 VOLTS	MEANBP 7008. KPA	TGREGH 552.4 DEG.C	T03HTR 600.8 DEG.C
TDLDP 0.83 DEG.C		MEANCP 7047. KPA	TGREGC 104.2 DEG.C	T04HTR 619.2 DEG.C
TWODPR 20.5 DEG.C			TGCOMP 36.7 DEG.C	T05HTR 599.2 DEG.C
			TGBOUN 25.7 DEG.C	T06HTR 602.7 DEG.C
				T07HTR 602.1 DEG.C
				T08HTR 584.5 DEG.C
				T09HTR 606.7 DEG.C
				T10HTR 598.8 DEG.C
				T11HTR 581.4 DEG.C
				T12HTR 586.3 DEG.C
HEAT TO COOLER	CALCULATED PARAMETERS	VIBRATION	REMOTE CALCULATIONS	
FLOCLR 4.31 L/MIN	1 PWRIN 1749. WATTS	VX1HOR 0.5 CM/S	PWRROUT 212. WATTS	
TWINCL 25.0 DEG.C	2 QCOOLR 1545. WATTS	VY1VER 5.4 CM/S	INDPWR 228. WATTS	
TDLCL 5.16 DEG.C	3 QDSHPT 232. WATTS		PISTST 1.99 CM	
TWOCLR 28.78 DEG.C	4 EXTEFF 12.1 %		DISPST 1.29 CM	
	5 TAVHTR 599.8 DEG.C	PHASE ANGLES	DYNAMIC CALCULATIONS	
	6 INTEFF 12.1 %	PADISP 38.6 DEG.	PAMPC 837. KPA	
	8 AMPS 891. AMPS	PAPRES -6.6 DEG.	DISPCP 2.22 CM	
	9 QDISPG 0. WATTS	ENGINE SPEED	PISTCP 2.32 CM	
	10 QDISP 15. WATTS	FREQ 27.9 Hz	PDYNDB***** KPA	
	11 QREG1 116. WATTS		T18REG 370.2 DEG.C	
	12 QREG2 99. WATTS		T19REG 226.9 DEG.C	
	13 QREG3 35. WATTS		PDLCLR 9.84 KPA	
	14 PFP 958.7 KPA/CM		PDLREG 46.16 KPA	
	15 PFD 238.3 KPA/CM		PDLDIS121.51 KPA	
	16 NBEALE 0.00213			T03HED***** DEG.C

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APPENDIX C. - CONTINUED.

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 11/27/84 10:46:18.08 RDG 1550

FLUID NITROGEN BAROM 14.357 PSI REGENERATOR 1 DISPLACER 1 STANDARD PISTON

HEAT TO DASHPOT COOLING		POWER IN	ENGINE CHARGE PRESSURE	GAS TEMPERATURES	SURFACE TEMPERATURES
FLODP	4.03 L/MIN	AMPS1 528. AMPS	PRESUP 7157. KPA	TGEXP 569.4 DEG.C	T01HTR 601.3 DEG.C
		AMPS2 406. AMPS			T02HTR 615.8 DEG.C
TWINDP	19.3 DEG.C	VOLTG 2.05 VOLTS	MEANBP 7012. KPA	TGREGH 553.1 DEG.C	T03HTR 601.5 DEG.C
TDLDP	0.91 DEG.C		MEANCP 7052. KPA	TGREGC 106.5 DEG.C	T04HTR 618.7 DEG.C
TWODPR	20.4 DEG.C			TGCOMP 38.2 DEG.C	T05HTR 600.1 DEG.C
				TGBOUN 26.1 DEG.C	T06HTR 603.8 DEG.C
					T07HTR 603.2 DEG.C
					T08HTR 584.4 DEG.C
					T09HTR 607.5 DEG.C
- HEAT TO COOLER		CALCULATED PARAMETERS	VIBRATION	REMOTE CALCULATIONS	T10HTR 597.6 DEG.C
FLOCRL	4.33 L/MIN	1 PWRIN 1916. WATTS	VX1HOR 0.5 CM/S	PWRROUT 240. WATTS	T11HTR 581.0 DEG.C
TWINCL	25.0 DEG.C	2 QCOOLR 1714. WATTS	VY1VER 6.1 CM/S	INDPWR 258. WATTS	T12HTR 585.4 DEG.C
TDLCL	5.70 DEG.C	3 QDSHPT 256. WATTS		PISTST 2.18 CM	
TWOCLR	29.17 DEG.C	4 EXTEFF 12.5 %	PHASE ANGLES	DISPST 1.39 CM	
		5 TAVHTR 600.0 DEG.C	PADISP 37.9 DEG.		T13REG***** DEG.C
		6 INTEFF 12.3 %	PAPRES -6.3 DEG.	DYNAMIC CALCULATIONS	T14REG 494.9 DEG.C
		8 AMPS 934. AMPS		PAMPC 925. KPA	T15REG 380.4 DEG.C
		9 QDISPG 0. WATTS	ENGINE SPEED	DISPCP 2.31 CM	T16REG 389.0 DEG.C
		10 QDISP 15. WATTS	FREQ 27.9 HZ	PISTCP 2.40 CM	T17REG 389.0 DEG.C
		11 QREG1 115. WATTS		PDYNDB***** KPA	T18REG 372.2 DEG.C
		12 QREG2 100. WATTS		PDLCLR 11.54 KPA	T19REG 230.5 DEG.C
		13 QREG3 35. WATTS		PDLREG 52.27 KPA	
		14 PFP 962.8 KPA/CM		PDLDIS134.06 KPA	
		15 PFD 239.0 KPA/CM			T03HED***** DEG.C
		16 NBEALE 0.00219			

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 11/27/84 10:51:18.08 RDG 1551

FLUID NITROGEN BAROM 14.357 PSI REGENERATOR 1 DISPLACER 1 STANDARD PISTON

HEAT TO DASHPOT COOLING		POWER IN	ENGINE CHARGE PRESSURE	GAS TEMPERATURES	SURFACE TEMPERATURES
FLODP	4.01 L/MIN	AMPS1 546. AMPS	PRESUP 7160. KPA	TGEXP 568.4 DEG.C	T01HTR 601.8 DEG.C
		AMPS2 422. AMPS			T02HTR 615.0 DEG.C
TWINDP	19.2 DEG.C	VOLTG 2.13 VOLTS	MEANBP 7010. KPA	TGREGH 552.9 DEG.C	T03HTR 602.6 DEG.C
TDLDP	0.99 DEG.C		MEANCP 7049. KPA	TGREGC 108.3 DEG.C	T04HTR 617.5 DEG.C
TWODPR	20.4 DEG.C			TGCOMP 39.6 DEG.C	T05HTR 601.1 DEG.C
				TGBOUN 26.6 DEG.C	T06HTR 603.6 DEG.C
					T07HTR 603.0 DEG.C
					T08HTR 584.4 DEG.C
- HEAT TO COOLER		CALCULATED PARAMETERS	VIBRATION	REMOTE CALCULATIONS	T09HTR 607.4 DEG.C
FLOCRL	4.34 L/MIN	1 PWRIN 2061. WATTS	VX1HOR 0.6 CM/S	PWRROUT 268. WATTS	T10HTR 597.0 DEG.C
TWINCL	25.1 DEG.C	2 QCOOLR 1781. WATTS	VY1VER 6.8 CM/S	INDPWR 289. WATTS	T11HTR 580.0 DEG.C
TDLCL	5.92 DEG.C	3 QDSHPT 277. WATTS		PISTST 2.38 CM	T12HTR 584.0 DEG.C
TWOCLR	29.56 DEG.C	4 EXTEFF 13.0 %	PHASE ANGLES	DISPST 1.48 CM	
		5 TAVHTR 599.8 DEG.C	PADISP 37.4 DEG.		T13REG***** DEG.C
		6 INTEFF 13.1 %	PAPRES -6.0 DEG.	DYNAMIC CALCULATIONS	T14REG 496.1 DEG.C
		8 AMPS 968. AMPS		PAMPC 1009. KPA	T15REG 382.5 DEG.C
		9 QDISPG 0. WATTS	ENGINE SPEED	DISPCP 2.37 CM	T16REG 390.0 DEG.C
		10 QDISP 15. WATTS	FREQ 28.0 HZ	PISTCP 2.42 CM	T17REG 390.3 DEG.C
		11 QREG1 114. WATTS		PDYNDB***** KPA	T18REG 374.1 DEG.C
		12 QREG2 99. WATTS		PDLCLR 12.90 KPA	T19REG 233.1 DEG.C
		13 QREG3 34. WATTS		PDLREG 57.02 KPA	
		14 PFP 957.7 KPA/CM		PDLDIS140.51 KPA	
		15 PFD 232.4 KPA/CM			T03HED***** DEG.C
		16 NBEALE 0.00224			

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 11/27/84 10:56:18.08 RDG 1552

FLUID NITROGEN BAROM 14.357 PSI REGENERATOR 1 DISPLACER 1 STANDARD PISTON

HEAT TO DASHPOT COOLING		POWER IN	ENGINE CHARGE PRESSURE	GAS TEMPERATURES	SURFACE TEMPERATURES
FLODP	4.00 L/MIN	AMPS1 565. AMPS	PRESUP 7160. KPA	TGEXP 566.9 DEG.C	T01HTR 602.2 DEG.C
		AMPS2 437. AMPS			T02HTR 615.1 DEG.C
TWINDP	19.2 DEG.C	VOLTG 2.20 VOLTS	MEANBP 7010. KPA	TGREGH 552.1 DEG.C	T03HTR 604.1 DEG.C
TDLDP	1.10 DEG.C		MEANCP 7058. KPA	TGREGC 109.5 DEG.C	T04HTR 616.8 DEG.C
TWODPR	20.4 DEG.C			TGCOMP 40.9 DEG.C	T05HTR 602.7 DEG.C
				TGBOUN 27.3 DEG.C	T06HTR 604.2 DEG.C
					T07HTR 603.7 DEG.C
					T08HTR 584.2 DEG.C
- HEAT TO COOLER		CALCULATED PARAMETERS	VIBRATION	REMOTE CALCULATIONS	T09HTR 607.4 DEG.C
FLOCRL	4.35 L/MIN	1 PWRIN 2210. WATTS	VX1HOR 0.6 CM/S	PWRROUT 292. WATTS	T10HTR 596.9 DEG.C
TWINCL	25.2 DEG.C	2 QCOOLR 1948. WATTS	VY1VER 7.5 CM/S	INDPWR 314. WATTS	T11HTR 579.0 DEG.C
TDLCL	6.46 DEG.C	3 QDSHPT 306. WATTS		PISTST 2.56 CM	T12HTR 583.9 DEG.C
TWOCLR	29.99 DEG.C	4 EXTEFF 13.2 %	PHASE ANGLES	DISPST 1.56 CM	
		5 TAVHTR 600.0 DEG.C	PADISP 36.5 DEG.		T13REG***** DEG.C
		6 INTEFF 13.0 %	PAPRES -5.5 DEG.	DYNAMIC CALCULATIONS	T14REG 497.4 DEG.C
		8 AMPS 1002. AMPS		PAMPC 1102. KPA	T15REG 385.4 DEG.C
		9 QDISPG 0. WATTS	ENGINE SPEED	DISPCP 2.47 CM	T16REG 391.0 DEG.C
		10 QDISP 15. WATTS	FREQ 28.0 HZ	PISTCP 2.41 CM	T17REG 391.1 DEG.C
		11 QREG1 112. WATTS		PDYNDB***** KPA	T18REG 375.3 DEG.C
		12 QREG2 99. WATTS		PDLCLR 14.93 KPA	T19REG 236.7 DEG.C
		13 QREG3 34. WATTS		PDLREG 61.09 KPA	
		14 PFP 967.5 KPA/CM		PDLDIS154.77 KPA	
		15 PFD 226.5 KPA/CM			T03HED***** DEG.C
		16 NBEALE 0.00226			

APPENDIX C. - CONTINUED.

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 12/07/84 10:54:18.64 RDG 1604

FLUID HELIUM		BAROM 14.386 PSI REGENERATOR 1 DISPLACER 1 LIGHT PISTON				SURFACE TEMPERATURES	
HEAT TO DASHPOT COOLING	POWER IN	ENGINE CHARGE PRESSURE	GAS TEMPERATURES				
FLODP 4.58 L/MIN	AMPS1 531. AMPS	PRESUP 7243. KPA	TGEXP 568.2 DEG.C	T01HTR 599.2 DEG.C			
	AMPS2 399. AMPS			T02HTR 609.4 DEG.C			
TWINDP 20.6 DEG.C	VOLTG 2.05 VOLTS	MEANBP 6994. KPA	TGREGH 565.8 DEG.C	T03HTR 606.0 DEG.C			
TDLDP 1.22 DEG.C		MEANCP 7024. KPA	TGREGC 92.5 DEG.C	T04HTR 608.2 DEG.C			
TWODPR 21.7 DEG.C			TGCOMP 36.2 DEG.C	T05HTR 609.2 DEG.C			
			TGBOUN 27.3 DEG.C	T06HTR 608.3 DEG.C			
				T07HTR 607.5 DEG.C			
				T08HTR 581.7 DEG.C			
				T09HTR 609.0 DEG.C			
HEAT TO COOLER	CALCULATED PARAMETERS	VIBRATION	REMOTE CALCULATIONS	T10HTR 586.6 DEG.C			
FLOCLR 4.20 L/MIN	1 PWRIN 1902. WATTS	VX1HOR 0.4 CM/S	PWRROUT 315. WATTS	T11HTR 582.4 DEG.C			
TWINCL 24.6 DEG.C	2 QCOOLR 1779. WATTS	VY1VER 4.1 CM/S	INDPWR 327. WATTS	T12HTR 581.5 DEG.C			
TDLCL 6.10 DEG.C	3 QDSHPT 387. WATTS		PISTST 1.78 CM				
TWOCLR 28.53 DEG.C	4 EXTEFF 16.5 %	PHASE ANGLES	DISPST 1.42 CM				
	5 TAVHTR 599.1 DEG.C	PADISP 40.8 DEG.		T13REG***** DEG.C			
	6 INTEFF 15.0 %	PAPRES -10.1 DEG.		T14REG 519.1 DEG.C			
	8 AMPS 930. AMPS		DYNAMIC CALCULATIONS	T15REG 387.9 DEG.C			
	9 QDISPG 3. WATTS	ENGINE SPEED	PAMPC 733. KPA	T16REG 394.2 DEG.C			
	10 QDISP 15. WATTS	FREQ 36.8 HZ	DISPCP 2.05 CM	T17REG 391.1 DEG.C			
	11 QREG1 120. WATTS		PISTCP 2.30 CM	T18REG 375.7 DEG.C			
	12 QREG2 116. WATTS		PDYNDR***** KPA	T19REG 227.8 DEG.C			
	13 QREG3 37. WATTS		PDLCLR 2.21 KPA				
	14 PFP 980.4 KPA/CM		PDLREG 24.44 KPA				
	15 PFD 277.1 KPA/CM		PDLDIS 48.19 KPA				
	16 NBEALE 0.00268			T03HED***** DEG.C			

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 12/07/84 11:00:27.64 RDG 1605

FLUID HELIUM		BAROM 14.386 PSI REGENERATOR 1 DISPLACER 1 LIGHT PISTON				SURFACE TEMPERATURES	
HEAT TO DASHPOT COOLING	POWER IN	ENGINE CHARGE PRESSURE	GAS TEMPERATURES				
FLODP 4.54 L/MIN	AMPS1 574. AMPS	PRESUP 7312. KPA	TGEXP 565.5 DEG.C	T01HTR 600.4 DEG.C			
	AMPS2 423. AMPS			T02HTR 608.3 DEG.C			
TWINDP 20.1 DEG.C	VOLTG 2.20 VOLTS	MEANBP 7009. KPA	TGREGH 565.7 DEG.C	T03HTR 607.8 DEG.C			
TDLDP 1.38 DEG.C		MEANCP 7045. KPA	TGREGC 96.4 DEG.C	T04HTR 608.0 DEG.C			
TWODPR 21.4 DEG.C			TGCOMP 38.4 DEG.C	T05HTR 611.3 DEG.C			
			TGBOUN 28.3 DEG.C	T06HTR 609.0 DEG.C			
				T07HTR 608.3 DEG.C			
				T08HTR 581.6 DEG.C			
				T09HTR 610.9 DEG.C			
HEAT TO COOLER	CALCULATED PARAMETERS	VIBRATION	REMOTE CALCULATIONS	T10HTR 584.8 DEG.C			
FLOCLR 4.23 L/MIN	1 PWRIN 2189. WATTS	VX1HOR 0.4 CM/S	PWRROUT 381. WATTS	T11HTR 581.9 DEG.C			
TWINCL 25.2 DEG.C	2 QCOOLR 1957. WATTS	VY1VER 4.6 CM/S	INDPWR 392. WATTS	T12HTR 579.0 DEG.C			
TDLCL 6.67 DEG.C	3 QDSHPT 436. WATTS		PISTST 1.99 CM				
TWOCLR 29.74 DEG.C	4 EXTEFF 17.4 %	PHASE ANGLES	DISPST 1.54 CM				
	5 TAVHTR 599.3 DEG.C	PADISP 40.4 DEG.		T13REG***** DEG.C			
	6 INTEFF 16.3 %	PAPRES -9.4 DEG.		T14REG 520.7 DEG.C			
	8 AMPS 997. AMPS		DYNAMIC CALCULATIONS	T15REG 393.0 DEG.C			
	9 QDISPG 3. WATTS	ENGINE SPEED	PAMPC 837. KPA	T16REG 399.2 DEG.C			
	10 QDISP 15. WATTS	FREQ 37.0 HZ	DISPCP 2.16 CM	T17REG 395.0 DEG.C			
	11 QREG1 119. WATTS		PISTCP 2.37 CM	T18REG 380.8 DEG.C			
	12 QREG2 114. WATTS		PDYNDB***** KPA	T19REG 234.1 DEG.C			
	13 QREG3 36. WATTS		PDLCLR 3.05 KPA				
	14 PFP 989.2 KPA/CM		PDLREG 29.19 KPA				
	15 PFD 273.5 KPA/CM		PDLDIS 57.70 KPA				
	16 NBEALE 0.00287			T03HED***** DEG.C			

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 12/07/84 11:04:30.64 RDG 1606

FLUID HELIUM		BAROM 14.381 PSI REGENERATOR 1 DISPLACER 1 LIGHT PISTON				SURFACE TEMPERATURES	
HEAT TO DASHPOT COOLING	POWER IN	ENGINE CHARGE PRESSURE	GAS TEMPERATURES				
FLODP 4.50 L/MIN	AMPS1 599. AMPS	PRESUP 7318. KPA	TGEXP 563.8 DEG.C	T01HTR 604.0 DEG.C			
	AMPS2 448. AMPS			T02HTR 607.5 DEG.C			
TWINDP 19.7 DEG.C	VOLTG 2.30 VOLTS	MEANBP 6998. KPA	TGREGH 567.7 DEG.C	T03HTR 610.3 DEG.C			
TDLDP 1.57 DEG.C		MEANCP 7035. KPA	TGREGC 98.2 DEG.C	T04HTR 608.3 DEG.C			
TWODPR 21.2 DEG.C			TGCOMP 40.2 DEG.C	T05HTR 613.3 DEG.C			
			TGBOUN 29.1 DEG.C	T06HTR 609.6 DEG.C			
				T07HTR 608.9 DEG.C			
				T08HTR 584.1 DEG.C			
HEAT TO COOLER	CALCULATED PARAMETERS	VIBRATION	REMOTE CALCULATIONS	T09HTR 613.5 DEG.C			
FLOCLR 4.24 L/MIN	1 PWRIN 2411. WATTS	VX1HOR 0.4 CM/S	PWRROUT 424. WATTS	T10HTR 584.4 DEG.C			
TWINCL 25.3 DEG.C	2 QCOOLR 2182. WATTS	VY1VER 5.0 CM/S	INDPWR 432. WATTS	T11HTR 583.4 DEG.C			
TDLCL 7.41 DEG.C	3 QDSHPT 490. WATTS		PISTST 2.16 CM	T12HTR 576.9 DEG.C			
TWOCLR 30.29 DEG.C	4 EXTEFF 17.6 %	PHASE ANGLES	DISPST 1.64 CM				
	5 TAVHTR 600.3 DEG.C	PADISP 40.2 DEG.		T13REG***** DEG.C			
	6 INTEFF 16.3 %	PAPRES -9.1 DEG.		T14REG 521.0 DEG.C			
	8 AMPS 1047. AMPS		DYNAMIC CALCULATIONS	T15REG 394.3 DEG.C			
	9 QDISPG 3. WATTS	ENGINE SPEED	PAMPC 925. KPA	T16REG 401.6 DEG.C			
	10 QDISP 15. WATTS	FREQ 37.0 HZ	DISPCP 2.23 CM	T17REG 400.4 DEG.C			
	11 QREG1 121. WATTS		PISTCP 2.36 CM	T18REG 386.0 DEG.C			
	12 QREG2 109. WATTS		PDYNDB***** KPA	T19REG 236.3 DEG.C			
	13 QREG3 36. WATTS		PDLCLR 3.39 KPA				
	14 PFP 1003.4 KPA/CM		PDLREG 31.90 KPA				
	15 PFD 275.1 KPA/CM		PDLDIS 62.45 KPA				
	16 NBEALE 0.00294			T03HED***** DEG.C			

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APPENDIX C. - CONTINUED.

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 12/07/84 11:09:27.64 RDG 1607

FLUID HELIUM	BAROM 14.381 PSI	REGENERATOR 1	DISPLACER 1	LIGHT	PISTON	
HEAT TO DASHPOT COOLING	POWER IN	ENGINE CHARGE PRESSURE	GAS TEMPERATURES	SURFACE TEMPERATURES		
FLODP 4.33 L/MIN	AMPS1 632. AMPS	PRESUP 7309. KPA	TGEXP 561.1 DEG.C	T01HTR 605.5 DEG.C		
	AMPS2 480. AMPS			T02HTR 606.9 DEG.C		
TWINDP 19.4 DEG.C	VOLTG 2.45 VOLTS	MEANBP 6991. KPA	TGREGH 567.0 DEG.C	T03HTR 612.8 DEG.C		
TDLDP 1.81 DEG.C		MEANCP 7031. KPA	TGREGC 100.5 DEG.C	T04HTR 607.3 DEG.C		
TWODPR 21.2 DEG.C			TGCOMP 42.8 DEG.C	T05HTR 615.8 DEG.C		
			TGBOUN 29.7 DEG.C	T06HTR 610.6 DEG.C		
				T07HTR 609.8 DEG.C		
				T08HTR 584.3 DEG.C		
				T09HTR 614.4 DEG.C		
HEAT TO COOLER	CALCULATED PARAMETERS	VIBRATION	REMOTE CALCULATIONS	T10HTR 583.7 DEG.C		
FLOCRL 4.26 L/MIN	1 PWRIN 2721. WATTS	VX1HOR 0.4 CM/S	PWRROUT 498. WATTS	T11HTR 582.5 DEG.C		
TWINCL 25.4 DEG.C	2 QCQLR 2338. WATTS	VY1VER 6.0 CM/S	INDPWR 504. WATTS	T12HTR 575.3 DEG.C		
TDLCL 7.91 DEG.C	3 QDSHPT 546. WATTS		PISTST 2.39 CM			
TWOCLR 31.12 DEG.C	4 EXTEFF 18.3 %	PHASE ANGLES	DISPST 1.78 CM			
	5 TAVHTR 600.7 DEG.C	PADISP 40.5 DEG.	DYNAMIC CALCULATIONS	T13REG***** DEG.C		
	6 INTEFF 17.5 %	PAPRES -8.7 DEG.	PAMPC 1024. KPA	T14REG 521.6 DEG.C		
	8 AMPS 1112. AMPS		DISPCP 2.27 CM	T15REG 395.8 DEG.C		
	9 QDISPG 3. WATTS	ENGINE SPEED	PISTCP 2.39 CM	T16REG 401.9 DEG.C		
	10 QDISP 15. WATTS	FREQ 37.1 HZ	PDYNDB***** KPA	T17REG 401.2 DEG.C		
	11 QREG1 121. WATTS		PDLCLR 3.90 KPA	T18REG 388.8 DEG.C		
	12 QREG2 108. WATTS		PDLREG 36.66 KPA	T19REG 239.4 DEG.C		
	13 QREG3 36. WATTS		PDLDIS 71.27 KPA	T03HED***** DEG.C		
	14 PFP 997.3 KPA/CM					
	15 PFD 267.4 KPA/CM					
	16 NBEALE 0.00312					

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 12/07/84 14:42:20.19 RDG 1608

FLUID HELIUM	BAROM 14.322 PSI	REGENERATOR 1	DISPLACER 1	LIGHT	PISTON	
HEAT TO DASHPOT COOLING	POWER IN	ENGINE CHARGE PRESSURE	GAS TEMPERATURES	SURFACE TEMPERATURES		
FLODP 4.12 L/MIN	AMPS1 653. AMPS	PRESUP 7070. KPA	TGEXP 558.4 DEG.C	T01HTR 606.1 DEG.C		
	AMPS2 517. AMPS			T02HTR 606.3 DEG.C		
TWINDP 18.0 DEG.C	VOLTG 2.58 VOLTS	MEANBP 7016. KPA	TGREGH 566.1 DEG.C	T03HTR 614.3 DEG.C		
TDLDP 2.44 DEG.C		MEANCP 7063. KPA	TGREGC 102.3 DEG.C	T04HTR 606.5 DEG.C		
TWODPR 20.5 DEG.C			TGCOMP 46.1 DEG.C	T05HTR 617.5 DEG.C		
			TGBOUN 32.6 DEG.C	T06HTR 611.5 DEG.C		
				T07HTR 610.5 DEG.C		
				T08HTR 584.0 DEG.C		
HEAT TO COOLER	CALCULATED PARAMETERS	VIBRATION	REMOTE CALCULATIONS	T09HTR 615.3 DEG.C		
FLOCRL 4.26 L/MIN	1 PWRIN 3018. WATTS	VX1HOR 0.4 CM/S	PWRROUT 572. WATTS	T10HTR 582.2 DEG.C		
TWINCL 25.3 DEG.C	2 QCQLR 2618. WATTS	VY1VER 6.0 CM/S	INDPWR 571. WATTS	T11HTR 581.7 DEG.C		
TDLCL 8.86 DEG.C	3 QDSHPT 701. WATTS		PISTST 2.56 CM	T12HTR 573.3 DEG.C		
TWOCLR 31.88 DEG.C	4 EXTEFF 19.0 %	PHASE ANGLES	DISPST 1.90 CM			
	5 TAVHTR 600.8 DEG.C	PADISP 41.6 DEG.	DYNAMIC CALCULATIONS	T13REG***** DEG.C		
	6 INTEFF 17.9 %	PAPRES -8.1 DEG.	PAMPC 1102. KPA	T14REG 522.1 DEG.C		
	8 AMPS 1170. AMPS		DISPCP 2.28 CM	T15REG 398.0 DEG.C		
	9 QDISPG 3. WATTS	ENGINE SPEED	PISTCP 2.37 CM	T16REG 402.5 DEG.C		
	10 QDISP 15. WATTS	FREQ 37.4 HZ	PDYNDB***** KPA	T17REG 402.6 DEG.C		
	11 QREG1 119. WATTS		PDLCLR 4.41 KPA	T18REG 390.7 DEG.C		
	12 QREG2 107. WATTS		PDLREG 40.05 KPA	T19REG 243.5 DEG.C		
	13 QREG3 36. WATTS		PDLDIS 75.69 KPA	T03HED***** DEG.C		
	14 PFP 987.2 KPA/CM					
	15 PFD 245.5 KPA/CM					
	16 NBEALE 0.00331					

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 12/07/84 14:47:50.19 RDG 1609

FLUID HELIUM	BAROM 14.317 PSI	REGENERATOR 1	DISPLACER 1	LIGHT	PISTON	
HEAT TO DASHPOT COOLING	POWER IN	ENGINE CHARGE PRESSURE	GAS TEMPERATURES	SURFACE TEMPERATURES		
FLODP 4.11 L/MIN	AMPS1 685. AMPS	PRESUP 7072. KPA	TGEXP 555.2 DEG.C	T01HTR 606.3 DEG.C		
	AMPS2 546. AMPS			T02HTR 606.0 DEG.C		
TWINDP 18.0 DEG.C	VOLTG 2.71 VOLTS	MEANBP 7017. KPA	TGREGH 563.8 DEG.C	T03HTR 615.3 DEG.C		
TDLDP 2.62 DEG.C		MEANCP 7068. KPA	TGREGC 104.2 DEG.C	T04HTR 605.2 DEG.C		
TWODPR 20.6 DEG.C			TGCOMP 48.4 DEG.C	T05HTR 619.0 DEG.C		
			TGBOUN 33.2 DEG.C	T06HTR 612.0 DEG.C		
				T07HTR 611.2 DEG.C		
				T08HTR 583.1 DEG.C		
HEAT TO COOLER	CALCULATED PARAMETERS	VIBRATION	REMOTE CALCULATIONS	T09HTR 615.3 DEG.C		
FLOCRL 4.26 L/MIN	1 PWRIN 3342. WATTS	VX1HOR 0.4 CM/S	PWRROUT 639. WATTS	T10HTR 580.5 DEG.C		
TWINCL 25.3 DEG.C	2 QCQLR 2826. WATTS	VY1VER 6.5 CM/S	INDPWR 633. WATTS	T11HTR 579.8 DEG.C		
TDLCL 9.57 DEG.C	3 QDSHPT 749. WATTS		PISTST 2.77 CM	T12HTR 571.8 DEG.C		
TWOCLR 32.66 DEG.C	4 EXTEFF 19.1 %	PHASE ANGLES	DISPST 2.00 CM			
	5 TAVHTR 600.5 DEG.C	PADISP 42.0 DEG.	DYNAMIC CALCULATIONS	T13REG***** DEG.C		
	6 INTEFF 18.4 %	PAPRES -7.6 DEG.	PAMPC 1201. KPA	T14REG 521.9 DEG.C		
	8 AMPS 1231. AMPS		DISPCP 2.34 CM	T15REG 399.0 DEG.C		
	9 QDISPG 3. WATTS	ENGINE SPEED	PISTCP 2.37 CM	T16REG 401.8 DEG.C		
	10 QDISP 14. WATTS	FREQ 37.6 HZ	PDYNDB***** KPA	T17REG 402.7 DEG.C		
	11 QREG1 118. WATTS		PDLCLR 5.26 KPA	T18REG 391.1 DEG.C		
	12 QREG2 106. WATTS		PDLREG 44.12 KPA	T19REG 245.7 DEG.C		
	13 QREG3 36. WATTS		PDLDIS 82.47 KPA	T03HED***** DEG.C		
	14 PFP 987.4 KPA/CM					
	15 PFD 238.4 KPA/CM					
	16 NBEALE 0.00341					

APPENDIX C. - CONCLUDED.

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 12/07/84 14:52:20.19 RDG 1610

FLUID HELIUM BAROM 14.317 PSI REGENERATOR 1 DISPLACER 1 LIGHT PISTON

HEAT TO DASHPOT COOLING FLODP 4.10 L/MIN	POWER IN AMPS1 714. AMPS AMPS2 574. AMPS VOLTG 2.84 VOLTS	ENGINE CHARGE PRESSURE PRESUP 7077. KPA MEANBP 7018. KPA MEANCp 7075. KPA	GAS TEMPERATURES TGEXP 552.3 DEG.C TGREGH 561.9 DEG.C TGREGC 105.4 DEG.C TGCOMP 51.3 DEG.C TGBOUN 33.9 DEG.C	SURFACE TEMPERATURES T01HTR 607.1 DEG.C T02HTR 605.6 DEG.C T03HTR 617.6 DEG.C T04HTR 603.8 DEG.C T05HTR 621.5 DEG.C T06HTR 612.5 DEG.C T07HTR 611.9 DEG.C T08HTR 582.9 DEG.C T09HTR 615.1 DEG.C T10HTR 580.3 DEG.C T11HTR 578.2 DEG.C T12HTR 570.8 DEG.C
HEAT TO COOLER FLOC LR 4.27 L/MIN TWINCL 25.3 DEG.C TDLCL 10.44 DEG.C TWOCLR 33.54 DEG.C	CALCULATED PARAMETERS 1 PWRIN 3664. WATTS 2 QCOOLR 3090. WATTS 3 QDSHPT 823. WATTS 4 EXTEFF 19.2 % 5 TAVHTR 600.6 DEG.C 6 INTEFF 18.6 % 8 AMPS 1289. AMPS 9 QDISPG 3. WATTS 10 QDISP 14. WATTS 11 QREG1 117. WATTS 12 QREG2 106. WATTS 13 QREG3 35. WATTS 14 PFP 992.5 KPA/CM 15 PFD 230.9 KPA/CM 16 NBEALE 0.00347	VIBRATION VX1HOR 0.4 CM/S VY1VER 7.0 CM/S PHASE ANGLES PADISP 42.4 DEG. PAPRES -7.2 DEG. ENGINE SPEED FREQ 37.7 HZ	REMOTE CALCULATIONS PWRROUT 705. WATTS INDPWR 691. WATTS PISTST 2.99 CM DISPST 2.10 CM DYNAMIC CALCULATIONS PAMPC 1314. KPA DISPCP 2.33 CM PISTCP 2.34 CM PDYNDB***** KPA PDLCLR 6.45 KPA PDLREG 48.19 KPA PDLDIS 89.60 KPA	T13REG***** DEG.C T14REG 521.6 DEG.C T15REG 398.3 DEG.C T16REG 398.9 DEG.C T17REG 401.3 DEG.C T18REG 391.4 DEG.C T19REG 246.8 DEG.C T03HED***** DEG.C

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APPENDIX D

Other Data Points of Interest

By the definition of the SVDS and the DVDS, data points with both the high power regenerator and the high power displacer were eliminated. Since these data points may be of great interest for computer code validation, they were presented in this appendix. Although all of the data points are available on a microfiche card that may be obtained from NASA Lewis, it was felt that it would be easier to access the data from an appendix.

The 69 data points included in this appendix are those that have any combination of two of the following three set conditions: 7.0 MPa pressure 25 °C cooler temperature, and 600 °C heater temperature. If viewed from the format of figure 27, these include the row of 25 °C and 7.0 MPa, 25 °C, and 600 °C, and also the pair of 600 °C and 7.0 MPa.

APPENDIX D. - OTHER DATA POINTS OF INTEREST.

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 12/21/83 15:42:22.48 RDG 774

FLUID HELIUM		BAROM 14.411 PSI REGENERATOR 2 DISPLACER 2 STANDARD PISTON				SURFACE TEMPERATURES	
HEAT TO DASHPOT COOLING	FLODP	POWER IN	AMPS1	634. AMPS	ENGINE CHARGE PRESSURE	TGEXP 563.9 DEG.C	T01HTR 599.0 DEG.C
	4.02 L/MIN		AMPS2	499. AMPS	PRESUP 7345. KPA	T02HTR 609.0 DEG.C	T02HTR 609.0 DEG.C
		VOLTG	2.50 VOLTS		MEANBP 6998. KPA	T03HTR 606.6 DEG.C	T03HTR 606.6 DEG.C
					MEANCP 7049. KPA	T04HTR 597.5 DEG.C	T04HTR 597.5 DEG.C
					TGREGH 542.4 DEG.C	T05HTR 596.7 DEG.C	T05HTR 596.7 DEG.C
					TGREGC 115.9 DEG.C	T06HTR 600.7 DEG.C	T06HTR 600.7 DEG.C
					TGCOMP 68.4 DEG.C	T07HTR 572.7 DEG.C	T07HTR 572.7 DEG.C
					TGBOUN 44.1 DEG.C	T08HTR 605.0 DEG.C	T08HTR 605.0 DEG.C
						T09HTR 610.4 DEG.C	T09HTR 610.4 DEG.C
						T10HTR 597.6 DEG.C	T10HTR 597.6 DEG.C
						T11HTR 596.0 DEG.C	T11HTR 596.0 DEG.C
						T12HTR 604.5 DEG.C	T12HTR 604.5 DEG.C
HEAT TO COOLER	FLOCRL	CALCULATED PARAMETERS	VIBRATION		REMOTE CALCULATIONS		
	3.94 L/MIN	1 PWPIR 2831. WATTS	VX1HOR 0.2 CM/S		PWRROUT 606. WATTS		
		2 QCOOLR 1783. WATTS	VY1VER 6.5 CM/S		INDPWR 644. WATTS		
		3 QDSHPT 577. WATTS			PISTST 1.81 CM		
		4 EXTEFF 21.4 %	PHASE ANGLES		DISPST 1.80 CM		
		5 TAVHTR 599.6 DEG.C	PADISP 84.4 DEG.				
		6 INTEFF 25.4 %	PAPRES -17.5 DEG.				
		8 AMPS 1133. AMPS		DYNAMIC CALCULATIONS			
		9 QDISPG 3. WATTS	ENGINE SPEED	PAMPC 915. KPA			
		10 QDISP 14. WATTS	FREQ 32.4 HZ	DISPCP 2.54 CM			
		11 QREG1 101. WATTS		PISTCP 2.38 CM			
		12 QREG2 113. WATTS		PDYNDB 1138. KPA			
		13 QREG3 33. WATTS		PDLCLR***** KPA			
		14 PFP 995.8 KPA/CM		PDLREG***** KPA			
		15 PFD 306.5 KPA/CM		PDLDIS***** KPA			
		16 NBEALE 0.00576					T03HED***** DEG.C

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 12/21/83 15:48:10.48 RDG 775

FLUID HELIUM		BAROM 14.416 PSI REGENERATOR 2 DISPLACER 2 STANDARD PISTON				SURFACE TEMPERATURES	
HEAT TO DASHPOT COOLING	FLODP	POWER IN	AMPS1	668. AMPS	ENGINE CHARGE PRESSURE	TGEXP 561.9 DEG.C	T01HTR 599.7 DEG.C
	4.00 L/MIN		AMPS2	527. AMPS	PRESUP 7249. KPA	T02HTR 609.0 DEG.C	T02HTR 609.0 DEG.C
		VOLTG	2.63 VOLTS		MEANBP 6996. KPA	T03HTR 607.8 DEG.C	T03HTR 607.8 DEG.C
					MEANCP 7052. KPA	T04HTR 598.4 DEG.C	T04HTR 598.4 DEG.C
					TGREGH 540.6 DEG.C	T05HTR 596.9 DEG.C	T05HTR 596.9 DEG.C
					TGREGC 118.4 DEG.C	T06HTR 600.5 DEG.C	T06HTR 600.5 DEG.C
					TGCOMP 71.4 DEG.C	T07HTR 571.9 DEG.C	T07HTR 571.9 DEG.C
					TGBOUN 43.5 DEG.C	T08HTR 604.3 DEG.C	T08HTR 604.3 DEG.C
						T09HTR 611.4 DEG.C	T09HTR 611.4 DEG.C
HEAT TO COOLER	FLOCRL	CALCULATED PARAMETERS	VIBRATION		REMOTE CALCULATIONS		
	3.99 L/MIN	1 PWRI 3148. WATTS	VX1HOR 0.2 CM/S		PWRROUT 684. WATTS		
		2 QCOOLR 1781. WATTS	VY1VER 7.1 CM/S		INDPWR 729. WATTS		
		3 QDSHPT 608. WATTS			PISTST 2.00 CM		
		4 EXTEFF 21.7 %	PHASE ANGLES		DISPST 1.93 CM		
		5 TAVHTR 599.7 DEG.C	PADISP 84.5 DEG.				
		6 INTEFF 27.7 %	PAPRES -16.5 DEG.	DYNAMIC CALCULATIONS			
		8 AMPS 1196. AMPS		PAMPC 1004. KPA			
		9 QDISPG 3. WATTS	ENGINE SPEED	DISPCP 2.51 CM			
		10 QDISP 14. WATTS	FREQ 32.2 HZ	PISTCP 2.42 CM			
		11 QREG1 100. WATTS		PDYNDB 1188. KPA			
		12 QREG2 112. WATTS		PDLCLR***** KPA			
		13 QREG3 33. WATTS		PDLREG***** KPA			
		14 PFP 991.8 KPA/CM		PDLDIS***** KPA			
		15 PFD 296.7 KPA/CM					T03HED***** DEG.C
		16 NBEALE 0.00592					

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 12/21/83 15:52:31.48 RDG 776

FLUID HELIUM		BAROM 14.416 PSI REGENERATOR 2 DISPLACER 2 STANDARD PISTON				SURFACE TEMPERATURES	
HEAT TO DASHPOT COOLING	FLODP	POWER IN	AMPS1	707. AMPS	ENGINE CHARGE PRESSURE	TGEXP 558.7 DEG.C	T01HTR 599.5 DEG.C
	4.00 L/MIN		AMPS2	556. AMPS	PRESUP 7356. KPA	T02HTR 608.7 DEG.C	T02HTR 608.7 DEG.C
		VOLTG	2.78 VOLTS		MEANBP 7008. KPA	T03HTR 608.2 DEG.C	T03HTR 608.2 DEG.C
					MEANCP 7066. KPA	T04HTR 595.7 DEG.C	T04HTR 595.7 DEG.C
					TGREGH 537.8 DEG.C	T05HTR 596.3 DEG.C	T05HTR 596.3 DEG.C
					TGREGC 121.3 DEG.C	T06HTR 599.4 DEG.C	T06HTR 599.4 DEG.C
					TGCOMP 74.3 DEG.C	T07HTR 570.2 DEG.C	T07HTR 570.2 DEG.C
					TGBOUN 43.7 DEG.C	T08HTR 603.3 DEG.C	T08HTR 603.3 DEG.C
						T09HTR 611.7 DEG.C	T09HTR 611.7 DEG.C
HEAT TO COOLER	FLOCRL	CALCULATED PARAMETERS	VIBRATION		REMOTE CALCULATIONS		
	4.03 L/MIN	1 PWPIR 3513. WATTS	VX1HOR 0.3 CM/S		PWRROUT 772. WATTS		
		2 QCOOLR 2021. WATTS	VY1VER 7.8 CM/S		INDPWR 816. WATTS		
		3 QDSHPT 669. WATTS			PISTST 2.20 CM		
		4 EXTEFF 22.0 %	PHASE ANGLES		DISPST 2.05 CM		
		5 TAVHTR 599.2 DEG.C	PADISP 85.0 DEG.				
		6 INTEFF 27.6 %	PAPRES -15.5 DEG.	DYNAMIC CALCULATIONS			
		8 AMPS 1263. AMPS		PAMPC 1083. KPA			
		9 QDISPG 3. WATTS	ENGINE SPEED	DISPCP 2.52 CM			
		10 QDISP 14. WATTS	FREQ 32.1 HZ	PISTCP 2.43 CM			
		11 QREG1 97. WATTS		PDYNDB 1263. KPA			
		12 QREG2 112. WATTS		PDLCLR***** KPA			
		13 QREG3 32. WATTS		PDLREG***** KPA			
		14 PFP 973.2 KPA/CM		PDLDIS***** KPA			
		15 PFD 283.3 KPA/CM					T03HED***** DEG.C
		16 NBEALE 0.00608					

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APPENDIX D. - CONTINUED.

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 12/21/83 15:57:19.48 RDG 777

FLUID HELIUM		BAROM 14.416 PSI REGENERATOR 2 DISPLACER 2 STANDARD PISTON				SURFACE TEMPERATURES	
HEAT TO DASHPOT COOLING		POWER IN	ENGINE CHARGE PRESSURE	GAS TEMPERATURES		T01HTR	599.5 DEG.C
FLODP	3.98 L/MIN	AMPS1 748. AMPS	PRESUP 7351. KPA	TGEXP 555.7 DEG.C		T02HTR	609.0 DEG.C
TWINDP	17.0 DEG.C	AMPS2 592. AMPS	MEANBP 6998. KPA	TGREGH 534.7 DEG.C		T03HTR	609.3 DEG.C
TDLDP	2.78 DEG.C	VOLTG 2.95 VOLTS	MEANCP 7062. KPA	TGREGC 124.6 DEG.C		T04HTR	595.4 DEG.C
TWODPR	20.5 DEG.C			TGCOMP 78.3 DEG.C		T05HTR	597.1 DEG.C
				TGBOUN 44.0 DEG.C		T06HTR	598.4 DEG.C
						T07HTR	569.4 DEG.C
						T08HTR	602.2 DEG.C
						T09HTR	613.3 DEG.C
HEAT TO COOLER		CALCULATED PARAMETERS	VIBRATION	REMOTE CALCULATIONS		T10HTR	598.6 DEG.C
FLOCRL	4.05 L/MIN	1 PWRIN 3951. WATTS	VX1HOR 0.3 CM/S	PWRROUT 885. WATTS		T11HTR	594.7 DEG.C
TWINCL	54.6 DEG.C	2 QCOOLR 2261. WATTS	VY1VER 8.5 CM/S	INDPWR 911. WATTS		T12HTR	603.3 DEG.C
TDLCL	8.13 DEG.C	3 QDSHPT 771. WATTS		PISTST 2.40 CM			
TWOCLR	61.75 DEG.C	4 EXTEFF 22.4 %		DISPST 2.20 CM			
		5 TAVHTR 599.2 DEG.C	PADISP 84.9 DEG.	DYNAMIC CALCULATIONS	T13REG 545.2 DEG.C		
		6 INTEFF 28.1 %	PAPRES -14.7 DEG.	PAMPC 1196. KPA	T14REG 508.7 DEG.C		
		8 AMPS 1340. AMPS		DISPCP 2.55 CM	T15REG 387.7 DEG.C		
		9 QDISPG 3. WATTS	ENGINE SPEED	PISTCP 2.38 CM	T16REG***** DEG.C		
		10 QDISP 14. WATTS	FREQ 32.0 HZ	PDYNDB 1350. KPA	T17REG 368.9 DEG.C		
		11 QREG1 95. WATTS		PDLCLR***** KPA	T18REG 372.3 DEG.C		
		12 QREG2 111. WATTS		PDLREG***** KPA	T19REG 254.6 DEG.C		
		13 QREG3 32. WATTS		PDLDIS***** KPA	T03HED***** DEG.C		
		14 PFP 986.6 KPA/CM					
		15 PFD 277.1 KPA/CM					
		16 NBEALE 0.00641					

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 12/21/83 16:02:16.48 RDG 778

FLUID HELIUM		BAROM 14.411 PSI REGENERATOR 2 DISPLACER 2 STANDARD PISTON				SURFACE TEMPERATURES	
HEAT TO DASHPOT COOLING		POWER IN	ENGINE CHARGE PRESSURE	GAS TEMPERATURES		T01HTR	600.1 DEG.C
FLODP	3.97 L/MIN	AMPS1 792. AMPS	PRESUP 7349. KPA	TGEXP 553.7 DEG.C		T02HTR	611.1 DEG.C
TWINDP	17.0 DEG.C	AMPS2 619. AMPS	MEANBP 6998. KPA	TGREGH 532.1 DEG.C		T03HTR	611.9 DEG.C
TDLDP	3.13 DEG.C	VOLTG 3.11 VOLTS	MEANCP 7066. KPA	TGREGC 127.1 DEG.C		T04HTR	596.2 DEG.C
TWODPR	20.9 DEG.C			TGCOMP 82.4 DEG.C		T05HTR	599.5 DEG.C
				TGBOUN 44.7 DEG.C		T06HTR	597.9 DEG.C
						T07HTR	570.3 DEG.C
						T08HTR	602.1 DEG.C
						T09HTR	616.0 DEG.C
HEAT TO COOLER		CALCULATED PARAMETERS	VIBRATION	REMOTE CALCULATIONS		T10HTR	599.2 DEG.C
FLOCRL	4.07 L/MIN	1 PWRIN 4387. WATTS	VX1HOR 0.4 CM/S	PWRROUT 1000. WATTS		T11HTR	595.2 DEG.C
TWINCL	54.6 DEG.C	2 QCOOLR 2428. WATTS	VY1VER 9.1 CM/S	INDPWR 1005. WATTS		T12HTR	605.1 DEG.C
TDLCL	8.69 DEG.C	3 QDSHPT 865. WATTS		PISTST 2.61 CM			
TWOCLR	62.74 DEG.C	4 EXTEFF 22.8 %		DISPST 2.30 CM			
		5 TAVHTR 600.4 DEG.C	PADISP 83.6 DEG.	DYNAMIC CALCULATIONS	T13REG 545.5 DEG.C		
		6 INTEFF 29.2 %	PAPRES -13.7 DEG.	PAMPC 1294. KPA	T14REG 509.1 DEG.C		
		8 AMPS 1410. AMPS		DISPCP 2.77 CM	T15REG 389.4 DEG.C		
		9 QDISPG 3. WATTS	ENGINE SPEED	PISTCP 2.51 CM	T16REG***** DEG.C		
		10 QDISP 13. WATTS	FREQ 32.0 HZ	PDYNDB 1450. KPA	T17REG 363.3 DEG.C		
		11 QREG1 93. WATTS		PDLCLR***** KPA	T18REG 372.4 DEG.C		
		12 QREG2 111. WATTS		PDLREG***** KPA	T19REG 258.0 DEG.C		
		13 QREG3 31. WATTS		PDLDIS***** KPA	T03HED***** DEG.C		
		14 PFP 989.0 KPA/CM					
		15 PFD 267.2 KPA/CM					
		16 NBEALE 0.00666					

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 12/21/83 16:06:19.48 RDG 779

FLUID HELIUM		BAROM 14.411 PSI REGENERATOR 2 DISPLACER 2 STANDARD PISTON				SURFACE TEMPERATURES	
HEAT TO DASHPOT COOLING		POWER IN	ENGINE CHARGE PRESSURE	GAS TEMPERATURES		T01HTR	599.5 DEG.C
FLODP	3.97 L/MIN	AMPS1 834. AMPS	PRESUP 7347. KPA	TGEXP 549.9 DEG.C		T02HTR	610.0 DEG.C
TWINDP	17.1 DEG.C	AMPS2 644. AMPS	MEANBP 6998. KPA	TGREGH 529.2 DEG.C		T03HTR	612.1 DEG.C
TDLDP	3.37 DEG.C	VOLTG 3.26 VOLTS	MEANCP 7070. KPA	TGREGC 129.9 DEG.C		T04HTR	594.4 DEG.C
TWODPR	21.2 DEG.C			TGCOMP 86.5 DEG.C		T05HTR	599.4 DEG.C
				TGBOUN 45.1 DEG.C		T06HTR	596.6 DEG.C
						T07HTR	568.1 DEG.C
						T08HTR	600.7 DEG.C
						T09HTR	616.0 DEG.C
HEAT TO COOLER		CALCULATED PARAMETERS	VIBRATION	REMOTE CALCULATIONS		T10HTR	599.0 DEG.C
FLOCRL	4.08 L/MIN	1 PWRIN 4815. WATTS	VX1HOR 0.4 CM/S	PWRROUT 1075. WATTS		T11HTR	593.9 DEG.C
TWINCL	54.7 DEG.C	2 QCOOLR 2570. WATTS	VY1VER 9.7 CM/S	INDPWR 1093. WATTS		T12HTR	603.8 DEG.C
TDLCL	9.17 DEG.C	3 QDSHPT 932. WATTS		PISTST 2.80 CM			
TWOCLR	63.87 DEG.C	4 EXTEFF 22.3 %		DISPST 2.41 CM			
		5 TAVHTR 599.5 DEG.C	PADISP 83.8 DEG.	DYNAMIC CALCULATIONS	T13REG 543.8 DEG.C		
		6 INTEFF 29.5 %	PAPRES -13.1 DEG.	PAMPC 1393. KPA	T14REG 508.4 DEG.C		
		8 AMPS 1477. AMPS		DISPCP 2.82 CM	T15REG 391.2 DEG.C		
		9 QDISPG 3. WATTS	ENGINE SPEED	PISTCP 2.48 CM	T16REG***** DEG.C		
		10 QDISP 13. WATTS	FREQ 31.9 HZ	PDYNDB 1525. KPA	T17REG 362.5 DEG.C		
		11 QREG1 90. WATTS		PDLCLR***** KPA	T18REG 372.8 DEG.C		
		12 QREG2 110. WATTS		PDLREG***** KPA	T19REG 262.0 DEG.C		
		13 QREG3 31. WATTS		PDLDIS***** KPA	T03HED***** DEG.C		
		14 PFP 993.6 KPA/CM					
		15 PFD 263.2 KPA/CM					
		16 NBEALE 0.00669					

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APPENDIX D. - CONTINUED.

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 12/21/83 16:10:19.48 RDG 780

FLUID HELIUM		BAROM 14.411 PSI REGENERATOR 2 DISPLACER 2 STANDARD PISTON				SURFACE TEMPERATURES	
HEAT TO DASHPOT COOLING	FLODP 3.99 L/MIN	POWER IN	AMPS1 876. AMPS	ENGINE CHARGE PRESSURE	PRESUP 7350. KPA	TGEXP 547.1 DEG.C	T01HTR 601.4 DEG.C
			AMPS2 681. AMPS				T02HTR 609.4 DEG.C
TWINDP 17.0 DEG.C		VOLTG	3.44 VOLTS	MEANBP	7008. KPA	TGREGH 528.7 DEG.C	T03HTR 613.8 DEG.C
TDLDP 3.67 DEG.C				MEANCP	7087. KPA	TGREGC 132.8 DEG.C	T04HTR 593.1 DEG.C
TWODPR 21.6 DEG.C						TGCOMP 90.3 DEG.C	T05HTR 599.5 DEG.C
						TGBOUN 46.2 DEG.C	T06HTR 597.6 DEG.C
							T07HTR 565.5 DEG.C
							T08HTR 600.9 DEG.C
							T09HTR 616.2 DEG.C
							T10HTR 600.7 DEG.C
HEAT TO COOLER	FLOCRL 4.05 L/MIN	CALCULATED PARAMETERS		VIBRATION	VX1HOR 0.5 CM/S	REMOTE CALCULATIONS	T11HTR 594.6 DEG.C
TWINCL 54.0 DEG.C		1 PWRIN 5355. WATTS		VY1VER 10.4 CM/S	PWROUT 1175. WATTS		T12HTR 603.6 DEG.C
TDLCL 10.48 DEG.C		2 QCOOLR 2919. WATTS			INDPWR 1186. WATTS		
TWOCLR 64.54 DEG.C		3 QDSHPT 1018. WATTS			PISTST 3.00 CM		
		4 EXTEFF 21.9 %			DISPST 2.39 CM		
		5 TAVHTR 599.7 DEG.C		PHASE ANGLES		DYNAMIC CALCULATIONS	T13REG 542.0 DEG.C
		6 INTEFF 28.7 %		PADISP 84.3 DEG.		PAMPC 1516. KPA	T14REG 507.0 DEG.C
		8 AMPS 1557. AMPS		PAPRES -12.0 DEG.		DISPCP 2.89 CM	T15REG 391.8 DEG.C
		9 QDISPG 3. WATTS		ENGINE SPEED		PISTCP 2.35 CM	T16REG***** DEG.C
		10 QDISP 13. WATTS		FREQ 32.1 Hz		PDYNDB 1625. KPA	T17REG 366.9 DEG.C
		11 QREG1 90. WATTS				PDLCLR***** KPA	T18REG 376.1 DEG.C
		12 QREG2 106. WATTS				PDLREG***** KPA	T19REG 265.2 DEG.C
		13 QREG3 31. WATTS				PDLDIS***** KPA	
		14 PFP 1008.2 KPA/CM					T03HED***** DEG.C
		15 PFD 264.5 KPA/CM					
		16 NBEALE 0.00678					

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 01/06/84 13:00:19.43 RDG 804

FLUID HELIUM		BAROM 14.136 PSI REGENERATOR 2 DISPLACER 2 STANDARD PISTON				SURFACE TEMPERATURES	
HEAT TO DASHPOT COOLING	FLODP 4.12 L/MIN	POWER IN	AMPS1 623. AMPS	ENGINE CHARGE PRESSURE	PRESUP 7076. KPA	TGEXP 562.6 DEG.C	T01HTR 599.6 DEG.C
			AMPS2 515. AMPS				T02HTR 610.4 DEG.C
TWINDP 20.3 DEG.C		VOLTG	2.50 VOLTS	MEANBP	7010. KPA	TGREGH 540.1 DEG.C	T03HTR 609.8 DEG.C
TDLDP 1.54 DEG.C				MEANCP	7051. KPA	TGREGC 102.3 DEG.C	T04HTR 595.3 DEG.C
TWODPR 22.4 DEG.C						TGCOMP 56.2 DEG.C	T05HTR 600.9 DEG.C
						TGBOUN 36.6 DEG.C	T06HTR 601.1 DEG.C
							T07HTR 574.0 DEG.C
							T08HTR 602.8 DEG.C
							T09HTR 607.4 DEG.C
HEAT TO COOLER	FLOCRL 4.37 L/MIN	CALCULATED PARAMETERS		VIBRATION	VX1HOR 0.2 CM/S	REMOTE CALCULATIONS	T10HTR 598.8 DEG.C
TWINCL 39.4 DEG.C		1 PWRIN 2844. WATTS		VY1VER 6.5 CM/S	PWROUT 638. WATTS		T11HTR 593.9 DEG.C
TDLCL 5.40 DEG.C		2 QCOOLR 1629. WATTS			INDPWR 669. WATTS		T12HTR 607.6 DEG.C
TWOCLR 44.66 DEG.C		3 QDSHPT 441. WATTS			PISTST 1.80 CM		
		4 EXTEFF 22.4 %		PHASE ANGLES		DISPST 1.78 CM	
		5 TAVHTR 600.1 DEG.C		PADISP 83.6 DEG.			T13REG 552.8 DEG.C
		6 INTEFF 28.1 %		PAPRES -18.4 DEG.			T14REG 515.4 DEG.C
		8 AMPS 1139. AMPS		ENGINE SPEED		PAMPC 930. KPA	T15REG 389.0 DEG.C
		9 QDISPG 3. WATTS		FREQ 32.4 Hz		DISPCP 2.52 CM	T16REG***** DEG.C
		10 QDISP 14. WATTS				PISTCP 2.44 CM	T17REG 364.8 DEG.C
		11 QREG1 106. WATTS				PDYNDB 1075. KPA	T18REG 376.4 DEG.C
		12 QREG2 113. WATTS				PDLCLR***** KPA	T19REG 246.1 DEG.C
		13 QREG3 34. WATTS				PDLREG***** KPA	
		14 PFP 1019.6 KPA/CM				PDLDIS***** KPA	
		15 PFD 332.1 KPA/CM					T03HED***** DEG.C
		16 NBEALE 0.00608					

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 01/06/84 13:06:16.43 RDG 805

FLUID HELIUM		BAROM 14.140 PSI REGENERATOR 2 DISPLACER 2 STANDARD PISTON				SURFACE TEMPERATURES	
HEAT TO DASHPOT COOLING	FLODP 4.13 L/MIN	POWER IN	AMPS1 661. AMPS	ENGINE CHARGE PRESSURE	PRESUP 7084. KPA	TGEXP 560.4 DEG.C	T01HTR 599.2 DEG.C
			AMPS2 541. AMPS				T02HTR 610.0 DEG.C
TWINDP 20.3 DEG.C		VOLTG	2.64 VOLTS	MEANBP	6997. KPA	TGREGH 537.7 DEG.C	T03HTR 609.8 DEG.C
TDLDP 1.80 DEG.C				MEANCP	7043. KPA	TGREGC 105.7 DEG.C	T04HTR 595.5 DEG.C
TWODPR 22.7 DEG.C						TGCOMP 59.6 DEG.C	T05HTR 600.5 DEG.C
						TGBOUN 38.0 DEG.C	T06HTR 599.8 DEG.C
							T07HTR 572.6 DEG.C
							T08HTR 602.4 DEG.C
							T09HTR 609.4 DEG.C
HEAT TO COOLER	FLOCRL 4.37 L/MIN	CALCULATED PARAMETERS		VIBRATION	VX1HOR 0.2 CM/S	REMOTE CALCULATIONS	T10HTR 598.6 DEG.C
TWINCL 39.5 DEG.C		1 PWRIN 3173. WATTS		VY1VER 7.1 CM/S	PWROUT 727. WATTS		T11HTR 594.0 DEG.C
TDLCL 6.25 DEG.C		2 QCOOLR 1886. WATTS			INDPWR 765. WATTS		T12HTR 606.5 DEG.C
TWOCLR 45.58 DEG.C		3 QDSHPT 516. WATTS			PISTST 1.98 CM		
		4 EXTEFF 22.9 %		PHASE ANGLES		DISPST 1.91 CM	
		5 TAVHTR 599.9 DEG.C		PADISP 84.2 DEG.			T13REG 550.8 DEG.C
		6 INTEFF 27.8 %		PAPRES -17.5 DEG.			T14REG 513.6 DEG.C
		8 AMPS 1202. AMPS		ENGINE SPEED		PAMPC 1019. KPA	T15REG 388.1 DEG.C
		9 QDISPG 3. WATTS		FREQ 32.3 Hz		DISPCP 2.54 CM	T16REG***** DEG.C
		10 QDISP 14. WATTS				PISTCP 2.45 CM	T17REG 363.4 DEG.C
		11 QREG1 105. WATTS				PDYNDB 1175. KPA	T18REG 376.2 DEG.C
		12 QREG2 111. WATTS				PDLCLR***** KPA	T19REG 247.4 DEG.C
		13 QREG3 33. WATTS				PDLREG***** KPA	
		14 PFP 1012.1 KPA/CM				PDLDIS***** KPA	
		15 PFD 323.8 KPA/CM					T03HED***** DEG.C
		16 NBEALE 0.00632					

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APPENDIX D. - CONTINUED.

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 01/06/84 13:10:34.48 RDG 806

FLUID HELIUM BAROM 14.140 PSI REGENERATOR 2 DISPLACER 2 STANDARD PISTON

HEAT TO DASHPOT COOLING	POWER IN	ENGINE CHARGE PRESSURE	GAS TEMPERATURES	SURFACE TEMPERATURES
FLODP 4.12 L/MIN	AMPS1 702. AMPS	PRESUP 7058. KPA	TGEXP 556.9 DEG.C	T01HTR 599.3 DEG.C
	AMPS2 574. AMPS			T02HTR 609.0 DEG.C
TWINDP 20.2 DEG.C	VOLTG 2.80 VOLTS	MEANBP 6989. KPA	TGREGH 535.3 DEG.C	T03HTR 610.3 DEG.C
TDLDP 2.13 DEG.C		MEANCP 7036. KPA	TGREGC 108.4 DEG.C	T04HTR 594.1 DEG.C
TWODPR 23.0 DEG.C			TGCOMP 62.1 DEG.C	T05HTR 599.8 DEG.C
			TGBOUN 38.8 DEG.C	T06HTR 598.9 DEG.C
				T07HTR 570.4 DEG.C
				T08HTR 601.5 DEG.C
				T09HTR 509.8 DEG.C
HEAT TO COOLER	CALCULATED PARAMETERS	VIBRATION	REMOTE CALCULATIONS	T10HTR 598.7 DEG.C
FLOCLR 4.37 L/MIN	1 PWRIN 3568. WATTS	VXIHOR 0.3 CM/S	PWRROUT 827. WATTS	T11HTR 593.4 DEG.C
TWINCL 39.6 DEG.C	2 QCOOLR 2145. WATTS	VYIVER 7.8 CM/S	INDPWR 868. WATTS	T12HTR 605.2 DEG.C
TDLCL 7.12 DEG.C	3 QDSHPT 612. WATTS		PISTST 2.19 CM	
TWOCLR 46.49 DEG.C	4 EXTEFF 23.2 %	PHASE ANGLES	DISPST 2.04 CM	
	5 TAVHTR 599.2 DEG.C	PADISP 84.5 DEG.		T13REG 548.0 DEG.C
	6 INTEFF 27.8 %	PAPRES -16.6 DEG.		T14REG 511.3 DEG.C
	8 AMPS 1276. AMPS		DYNAMIC CALCULATIONS	T15REG 386.5 DEG.C
	9 QDISPG 3. WATTS	ENGINE SPEED	PAMPC 1127. KPA	T16REG***** DEG.C
	10 QDISP 14. WATTS	FREQ 32.2 HZ	DISPCP 2.58 CM	T17REG 363.4 DEG.C
	11 QREG1 104. WATTS		PISTCP 2.46 CM	T18REG 376.1 DEG.C
	12 QREG2 110. WATTS		PDYNDB 1263. KPA	T19REG 248.0 DEG.C
	13 QREG3 33. WATTS		PDLCLR***** KPA	
	14 PFP 1012.9 KPA/CM		PDLREG***** KPA	
	15 PFD 315.8 KPA/CM		PDLDIS***** KPA	
	16 NBEALE 0.00652			T03HED***** DEG.C

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 01/06/84 13:15:19.48 RDG 807

FLUID HELIUM BAROM 14.140 PSI REGENERATOR 2 DISPLACER 2 STANDARD PISTON

HEAT TO DASHPOT COOLING	POWER IN	ENGINE CHARGE PRESSURE	GAS TEMPERATURES	SURFACE TEMPERATURES
FLODP 4.12 L/MIN	AMPS1 745. AMPS	PRESUP 7098. KPA	TGEXP 554.4 DEG.C	T01HTR 600.7 DEG.C
	AMPS2 602. AMPS			T02HTR 607.8 DEG.C
TWINDP 20.3 DEG.C	VOLTG 2.95 VOLTS	MEANBP 7009. KPA	TGREGH 534.3 DEG.C	T03HTR 611.5 DEG.C
TDLDP 2.47 DEG.C		MEANCP 7065. KPA	TGREGC 113.3 DEG.C	T04HTR 593.6 DEG.C
TWODPR 23.3 DEG.C			TGCOMP 65.8 DEG.C	T05HTR 598.8 DEG.C
			TGBOUN 40.1 DEG.C	T06HTR 599.5 DEG.C
				T07HTR 567.7 DEG.C
				T08HTR 601.9 DEG.C
				T09HTR 611.4 DEG.C
HEAT TO COOLER	CALCULATED PARAMETERS	VIBRATION	REMOTE CALCULATIONS	T10HTR 600.1 DEG.C
FLOCLR 4.38 L/MIN	1 PWRIN 3977. WATTS	VXIHOR 0.3 CM/S	PWRROUT 930. WATTS	T11HTR 594.3 DEG.C
TWINCL 39.7 DEG.C	2 QCOOLR 2443. WATTS	VYIVER 8.4 CM/S	INDPWR 973. WATTS	T12HTR 603.9 DEG.C
TDLCL 8.08 DEG.C	3 QDSHPT 708. WATTS		PISTST 2.40 CM	
TWOCLR 47.47 DEG.C	4 EXTEFF 23.4 %	PHASE ANGLES	DISPST 2.18 CM	
	5 TAVHTR 599.3 DEG.C	PADISP 84.6 DEG.		T13REG 545.5 DEG.C
	6 INTEFF 27.6 %	PAPRES -15.7 DEG.		T14REG 509.0 DEG.C
	8 AMPS 1347. AMPS		DYNAMIC CALCULATIONS	T15REG 384.4 DEG.C
	9 QDISPG 3. WATTS	ENGINE SPEED	PAMPC 1235. KPA	T16REG***** DEG.C
	10 QDISP 14. WATTS	FREQ 32.2 HZ	DISPCP 2.62 CM	T17REG 366.0 DEG.C
	11 QREG1 104. WATTS		PISTCP 2.46 CM	T18REG 376.0 DEG.C
	12 QREG2 108. WATTS		PDYNDB 1363. KPA	T19REG 247.9 DEG.C
	13 QREG3 33. WATTS		PDLCLR***** KPA	
	14 PFP 1018.6 KPA/CM		PDLREG***** KPA	
	15 PFD 308.2 KPA/CM		PDLDIS***** KPA	
	16 NBEALE 0.00670			T03HED***** DEG.C

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 01/06/84 13:21:04.48 RDG 808

FLUID HELIUM BAROM 14.140 PSI REGENERATOR 2 DISPLACER 2 STANDARD PISTON

HEAT TO DASHPOT COOLING	POWER IN	ENGINE CHARGE PRESSURE	GAS TEMPERATURES	SURFACE TEMPERATURES
FLODP 4.12 L/MIN	AMPS1 772. AMPS	PRESUP 7092. KPA	TGEXP 551.3 DEG.C	T01HTR 602.3 DEG.C
	AMPS2 627. AMPS			T02HTR 606.0 DEG.C
TWINDP 20.3 DEG.C	VOLTG 3.08 VOLTS	MEANBP 6987. KPA	TGREGH 533.7 DEG.C	T03HTR 612.4 DEG.C
TDLDP 2.83 DEG.C		MEANCP 7051. KPA	TGREGC 116.6 DEG.C	T04HTR 592.6 DEG.C
TWODPR 23.6 DEG.C			TGCOMP 69.6 DEG.C	T05HTR 596.3 DEG.C
			TGBOUN 41.5 DEG.C	T06HTR 599.9 DEG.C
				T07HTR 564.9 DEG.C
				T08HTR 602.1 DEG.C
				T09HTR 612.0 DEG.C
HEAT TO COOLER	CALCULATED PARAMETERS	VIBRATION	REMOTE CALCULATIONS	T10HTR 601.6 DEG.C
FLOCLR 4.37 L/MIN	1 PWRIN 4307. WATTS	VXIHOR 0.4 CM/S	PWRROUT 1006. WATTS	T11HTR 595.1 DEG.C
TWINCL 39.7 DEG.C	2 QCOOLR 2868. WATTS	VYIVER 9.0 CM/S	INDPWR 1051. WATTS	T12HTR 602.3 DEG.C
TDLCL 8.90 DEG.C	3 QDSHPT 811. WATTS		PISTST 2.59 CM	
TWOCLR 48.29 DEG.C	4 EXTEFF 23.4 %	PHASE ANGLES	DISPST 2.28 CM	
	5 TAVHTR 599.0 DEG.C	PADISP 84.4 DEG.		T13REG 542.2 DEG.C
	6 INTEFF 27.2 %	PAPRES -14.7 DEG.		T14REG 504.7 DEG.C
	8 AMPS 1399. AMPS		DYNAMIC CALCULATIONS	T15REG 379.1 DEG.C
	9 QDISPG 3. WATTS	ENGINE SPEED	PAMPC 1324. KPA	T16REG***** DEG.C
	10 QDISP 14. WATTS	FREQ 32.0 HZ	DISPCP 2.64 CM	T17REG 368.6 DEG.C
	11 QREG1 107. WATTS		PISTCP 2.44 CM	T18REG 376.3 DEG.C
	12 QREG2 104. WATTS		PDYNDB 1438. KPA	T19REG 244.8 DEG.C
	13 QREG3 32. WATTS		PDLCLR***** KPA	
	14 PFP 1012.5 KPA/CM		PDLREG***** KPA	
	15 PFD 296.8 KPA/CM		PDLDIS***** KPA	
	16 NBEALE 0.00676			T03HED***** DEG.C

APPENDIX D. - CONTINUED.

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 01/06/84 13:25:19.48 RDG 809

FLUID HELIUM		BAROM 14.140 PSI REGENERATOR 2 DISPLACER 2 STANDARD PISTON				SURFACE TEMPERATURES	
HEAT TO DASHPOT COOLING		POWER IN	ENGINE CHARGE PRESSURE	GAS TEMPERATURES			
FLODP 4.11 L/MIN		AMPS1 807. AMPS	PRESUP 7071. KPA	TGEXP 548.0 DEG.C	T01HTR 602.0 DEG.C		
		AMPS2 657. AMPS			T02HTR 605.5 DEG.C		
TWINDP 20.3 DEG.C		VOLTG 3.23 VOLTS	MEANBP 6995. KPA	TGREGH 531.8 DEG.C	T03HTR 612.7 DEG.C		
TDLDP 3.06 DEG.C			MEANCP 7063. KPA	TGREGC 119.2 DEG.C	T04HTR 591.3 DEG.C		
TWODPR 23.9 DEG.C				TGCOMP 73.6 DEG.C	T05HTR 596.1 DEG.C		
				TGBOUN 43.2 DEG.C	T06HTR 599.0 DEG.C		
					T07HTR 563.2 DEG.C		
					T08HTR 601.3 DEG.C		
					T09HTR 612.4 DEG.C		
HEAT TO COOLER		CALCULATED PARAMETERS	VIBRATION	REMOTE CALCULATIONS			
FLOC LR 4.39 L/MIN		1 PWRIN 4736. WATTS	VX1HOR 0.4 CM/S	PWRROUT 1089. WATTS	T10HTR 601.5 DEG.C		
TWINCL 39.7 DEG.C		2 QCOOLR 3031. WATTS	VY1VER 9.6 CM/S	INDPWR 1138. WATTS	T11HTR 594.8 DEG.C		
TDLCL 10.00 DEG.C		3 QDSHPT 874. WATTS		PISTST 2.79 CM	T12HTR 601.4 DEG.C		
TWOCLR 49.39 DEG.C		4 EXTEFF 23.0 %		DISPST 2.40 CM			
		5 TAVHTR 598.4 DEG.C	PHASE ANGLES	DYNAMIC CALCULATIONS			
		6 INTEFF 26.4 %	PADISP 84.9 DEG.	PAMPC 1427. KPA	T13REG 540.6 DEG.C		
		8 AMPS 1464. AMPS	PAPRES -13.8 DEG.	DISPCP 2.67 CM	T14REG 503.7 DEG.C		
		9 QDISPG 3. WATTS		PISTCP 2.39 CM	T15REG 380.7 DEG.C		
		10 QDISP 13. WATTS	ENGINE SPEED	PDYNDB 1494. KPA	T16REG***** DEG.C		
		11 QREG1 103. WATTS	FREQ 31.9 HZ	PDLCLR***** KPA	T17REG 368.5 DEG.C		
		12 QREG2 104. WATTS		PDLREG***** KPA	T18REG 376.1 DEG.C		
		13 QREG3 32. WATTS		PDLDIS***** KPA	T19REG 248.8 DEG.C		
		14 PFP 1014.3 KPA/CM			T03HED***** DEG.C		
		15 PFD 284.2 KPA/CM					
		16 NBEALE 0.00680					

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 01/11/84 13:59:30.48 RDG 810

FLUID HELIUM		BAROM 14.489 PSI REGENERATOR 2 DISPLACER 2 STANDARD PISTON				SURFACE TEMPERATURES	
HEAT TO DASHPOT COOLING		POWER IN	ENGINE CHARGE PRESSURE	GAS TEMPERATURES			
FLODP 4.04 L/MIN		AMPS1 838. AMPS	PRESUP 7493. KPA	TGEXP 545.2 DEG.C	T01HTR 604.3 DEG.C		
		AMPS2 709. AMPS			T02HTR 606.4 DEG.C		
TWINDP 17.7 DEG.C		VOLTG 3.40 VOLTS	MEANBP 6998. KPA	TGREGH 529.9 DEG.C	T03HTR 614.7 DEG.C		
TDLDP 3.08 DEG.C			MEANCP 7065. KPA	TGREGC 116.5 DEG.C	T04HTR 591.2 DEG.C		
TWODPR 21.4 DEG.C				TGCOMP 75.0 DEG.C	T05HTR 595.7 DEG.C		
				TGBOUN 38.1 DEG.C	T06HTR 600.3 DEG.C		
					T07HTR 561.9 DEG.C		
					T08HTR 601.4 DEG.C		
					T09HTR 613.5 DEG.C		
HEAT TO COOLER		CALCULATED PARAMETERS	VIBRATION	REMOTE CALCULATIONS			
FLOC LR 4.51 L/MIN		1 PWRIN 5261. WATTS	VX1HOR 0.6 CM/S	PWRROUT 1219. WATTS	T10HTR 603.2 DEG.C		
TWINCL 39.3 DEG.C		2 QCOOLR 3181. WATTS	VY1VER 10.2 CM/S	INDPWR 1240. WATTS	T11HTR 595.0 DEG.C		
TDLCL 10.03 DEG.C		3 QDSHPT 866. WATTS		PISTST 2.98 CM	T12HTR 601.5 DEG.C		
TWOCLR 48.65 DEG.C		4 EXTEFF 23.2 %		DISPST 2.48 CM			
		5 TAVHTR 599.1 DEG.C	PHASE ANGLES	DYNAMIC CALCULATIONS			
		6 INTEFF 27.7 %	PADISP 84.7 DEG.	PAMPC 1536. KPA	T13REG***** DEG.C		
		8 AMPS 1547. AMPS	PAPRES -12.8 DEG.	DISPCP 2.81 CM	T14REG 501.8 DEG.C		
		9 QDISPG 3. WATTS		PISTCP 2.28 CM	T15REG 380.7 DEG.C		
		10 QDISP 13. WATTS	ENGINE SPEED	PDYNDB 1588. KPA	T16REG***** DEG.C		
		11 QREG1 104. WATTS	FREQ 32.1 HZ	PDLCLR***** KPA	T17REG 369.1 DEG.C		
		12 QREG2 100. WATTS		PDLREG***** KPA	T18REG 378.4 DEG.C		
		13 QREG3 32. WATTS		PDLDIS***** KPA	T19REG 250.2 DEG.C		
		14 PFP 1025.8 KPA/CM			T03HED***** DEG.C		
		15 PFD 275.7 KPA/CM					
		16 NBEALE 0.00710					

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 01/11/84 14:04:09.48 RDG 811

FLUID HELIUM		BAROM 14.489 PSI REGENERATOR 2 DISPLACER 2 STANDARD PISTON				SURFACE TEMPERATURES	
HEAT TO DASHPOT COOLING		POWER IN	ENGINE CHARGE PRESSURE	GAS TEMPERATURES			
FLODP 4.03 L/MIN		AMPS1 868. AMPS	PRESUP 7503. KPA	TGEXP 542.6 DEG.C	T01HTR 606.1 DEG.C		
		AMPS2 734. AMPS			T02HTR 605.2 DEG.C		
TWINDP 17.7 DEG.C		VOLTG 3.54 VOLTS	MEANBP 6988. KPA	TGREGH 530.1 DEG.C	T03HTR 616.0 DEG.C		
TDLDP 3.45 DEG.C			MEANCP 7061. KPA	TGREGC 122.5 DEG.C	T04HTR 590.4 DEG.C		
TWODPR 21.8 DEG.C				TGCOMP 79.2 DEG.C	T05HTR 596.1 DEG.C		
				TGBOUN 41.0 DEG.C	T06HTR 601.2 DEG.C		
					T07HTR 559.9 DEG.C		
					T08HTR 602.7 DEG.C		
					T09HTR 614.0 DEG.C		
HEAT TO COOLER		CALCULATED PARAMETERS	VIBRATION	REMOTE CALCULATIONS			
FLOC LR 4.51 L/MIN		1 PWRIN 5666. WATTS	VX1HOR 0.6 CM/S	PWRROUT 1290. WATTS	T10HTR 605.1 DEG.C		
TWINCL 39.8 DEG.C		2 QCOOLR 3468. WATTS	VY1VER 10.9 CM/S	INDPWR 1299. WATTS	T11HTR 596.9 DEG.C		
TDLCL 11.15 DEG.C		3 QDSHPT 969. WATTS		PISTST 3.20 CM	T12HTR 601.2 DEG.C		
TWOCLR 50.71 DEG.C		4 EXTEFF 22.8 %		DISPST 2.59 CM			
		5 TAVHTR 599.6 DEG.C	PHASE ANGLES	DYNAMIC CALCULATIONS			
		6 INTEFF 27.1 %	PADISP 84.2 DEG.	PAMPC 1639. KPA	T13REG***** DEG.C		
		8 AMPS 1601. AMPS	PAPRES -12.0 DEG.	DISPCP 2.81 CM	T14REG 499.9 DEG.C		
		9 QDISPG 3. WATTS		PISTCP 2.17 CM	T15REG 377.8 DEG.C		
		10 QDISP 13. WATTS	ENGINE SPEED	PDYNDB 1650. KPA	T16REG***** DEG.C		
		11 QREG1 104. WATTS	FREQ 32.0 HZ	T17REG 371.7 DEG.C			
		12 QREG2 99. WATTS		T18REG 378.2 DEG.C			
		13 QREG3 32. WATTS		T19REG 250.0 DEG.C			
		14 PFP 1025.1 KPA/CM			T03HED***** DEG.C		
		15 PFD 265.2 KPA/CM					
		16 NBEALE 0.00703					

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APPENDIX D. - CONTINUED.

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 01/11/84 14:07:18.48 RDG 812

FLUID HELIUM		BAROM 14.494 PSI		REGENERATOR 2	DISPLACER 2	STANDARD PISTON	
HEAT TO DASHPOT COOLING	FLODP 4.03 L/MIN	POWER IN		ENGINE CHARGE PRESSURE		GAS TEMPERATURES	SURFACE TEMPERATURES
		AMPS1 895. AMPS		PRESUP 7427. KPA		TGEXP 541.0 DEG.C	T01HTR 607.2 DEG.C
		AMPS2 791. AMPS				TGREGH 530.6 DEG.C	T02HTR 606.2 DEG.C
TWINDP 17.7 DEG.C		VOLTG 3.70 VOLTS		MEANBP 7014. KPA		TGREGC 127.5 DEG.C	T03HTR 617.1 DEG.C
TDLDP 3.69 DEG.C				MEANCP 7097. KPA		TGCOMP 83.6 DEG.C	T04HTR 591.2 DEG.C
TWODPR 22.2 DEG.C						TGBOUN 42.8 DEG.C	T05HTR 596.3 DEG.C
							T06HTR 601.3 DEG.C
							T07HTR 559.4 DEG.C
							T08HTR 604.2 DEG.C
							T09HTR 616.8 DEG.C
							T10HTR 606.1 DEG.C
HEAT TO COOLER	FLOCLR 4.51 L/MIN	CALCULATED PARAMETERS		VIBRATION		REMOTE CALCULATIONS	
		1 PWRIN 6242. WATTS		VX1HOR 0.7 CM/S		PWROUT 1377. WATTS	T11HTR 598.7 DEG.C
		2 QCOOLR 3840. WATTS		VY1VER11.6 CM/S		INDPWR 1378. WATTS	T12HTR 601.1 DEG.C
TWINCL 39.9 DEG.C		3 QDSHPT 1035. WATTS				PISTST 3.39 CM	
TDLCL 12.34 DEG.C		4 EXTEFF 22.1 %		PHASE ANGLES		DISPST 2.70 CM	
TWOCLR 52.00 DEG.C		5 TAVHTR 600.5 DEG.C		PADISP 83.9 DEG.			T13REG***** DEG.C
		6 INTEFF 26.4 %		PAPRES -11.0 DEG.			T14REG 499.6 DEG.C
		8 AMPS 1686. AMPS		ENGINE SPEED		PAMPC 1762. KPA	T15REG 379.5 DEG.C
		9 QDISPG 3. WATTS		FREQ 32.1 HZ		DISPCP 2.84 CM	T16REG***** DEG.C
		10 QDISP 13. WATTS				PISTCP 2.04 CM	T17REG 374.0 DEG.C
		11 QREG1 101. WATTS				PDYNDB 1750. KPA	T18REG 378.3 DEG.C
		12 QREG2 98. WATTS				PDLCLR***** KPA	T19REG 253.4 DEG.C
		13 QREG3 31. WATTS				PDLREG***** KPA	
		14 PFP 1040.7 KPA/CM				PDLDIS***** KPA	
		15 PFD 251.4 KPA/CM					T03HED***** DEG.C
		16 NBEALE 0.00702					

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 01/16/84 13:57:19.44 RDG 862

FLUID HELIUM		BAROM 14.332 PSI		REGENERATOR 2	DISPLACER 2	STANDARD PISTON	
HEAT TO DASHPOT COOLING	FLODP 4.32 L/MIN	POWER IN		ENGINE CHARGE PRESSURE		GAS TEMPERATURES	SURFACE TEMPERATURES
		AMPS1 401. AMPS		PRESUP 4030. KPA		TGEXP 557.6 DEG.C	T01HTR 599.7 DEG.C
		AMPS2 468. AMPS				TGREGH 545.1 DEG.C	T02HTR 606.4 DEG.C
TWINDP 17.9 DEG.C		VOLTG 1.91 VOLTS		MEANBP 3998. KPA		TGREGC 79.1 DEG.C	T03HTR 603.2 DEG.C
TDLDP 0.85 DEG.C				MEANCP 4026. KPA		TGCOMP 36.8 DEG.C	T04HTR 599.0 DEG.C
TWODPR 19.4 DEG.C						TGBOUN 33.8 DEG.C	T05HTR 597.5 DEG.C
							T06HTR 602.2 DEG.C
							T07HTR 578.8 DEG.C
							T08HTR 606.1 DEG.C
							T09HTR 607.3 DEG.C
HEAT TO COOLER	FLOCLR 4.17 L/MIN	CALCULATED PARAMETERS		VIBRATION		REMOTE CALCULATIONS	
		1 PWRIN 1663. WATTS		VX1HOR 0.2 CM/S		PWROUT 355. WATTS	T10HTR 598.6 DEG.C
		2 QCOOLR 915. WATTS		VY1VER 4.4 CM/S		INDPWR 369. WATTS	T11HTR 598.4 DEG.C
TWINCL 25.0 DEG.C		3 QDSHPT 256. WATTS				PISTST 1.82 CM	T12HTR 602.8 DEG.C
TDLCL 3.16 DEG.C		4 EXTEFF 21.4 %		PHASE ANGLES		DISPST 1.89 CM	
TWOCLR 28.66 DEG.C		5 TAVHTR 600.0 DEG.C		PADISP 80.0 DEG.			T13REG***** DEG.C
		6 INTEFF 28.0 %		PAPRES -21.7 DEG.			T14REG 508.6 DEG.C
		8 AMPS 869. AMPS		ENGINE SPEED		PAMPC 541. KPA	T15REG 375.0 DEG.C
		9 QDISPG 3. WATTS		FREQ 24.9 HZ		DISPCP 2.63 CM	T16REG***** DEG.C
		10 QDISP 15. WATTS				PISTCP 2.50 CM	T17REG 358.6 DEG.C
		11 QREG1 108. WATTS				PDYNDB 625. KPA	T18REG 352.8 DEG.C
		12 QREG2 126. WATTS				PDLCLR***** KPA	T19REG 219.7 DEG.C
		13 QREG3 36. WATTS				PDLREG***** KPA	
		14 PFP 591.7 KPA/CM				PDLDIS***** KPA	
		15 PFD 214.5 KPA/CM					T03HED***** DEG.C
		16 NBEALE 0.00764					

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 01/16/84 14:02:19.44 RDG 863

FLUID HELIUM		BAROM 14.332 PSI		REGENERATOR 2	DISPLACER 2	STANDARD PISTON	
HEAT TO DASHPOT COOLING	FLODP 4.34 L/MIN	POWER IN		ENGINE CHARGE PRESSURE		GAS TEMPERATURES	SURFACE TEMPERATURES
		AMPS1 424. AMPS		PRESUP 4033. KPA		TGEXP 554.9 DEG.C	T01HTR 599.6 DEG.C
		AMPS2 486. AMPS				TGREGH 543.1 DEG.C	T02HTR 605.6 DEG.C
TWINDP 17.9 DEG.C		VOLTG 2.00 VOLTS		MEANBP 4004. KPA		TGREGC 79.7 DEG.C	T03HTR 602.9 DEG.C
TDLDP 0.90 DEG.C				MEANCP 4036. KPA		TGCOMP 37.6 DEG.C	T04HTR 597.2 DEG.C
TWODPR 19.4 DEG.C						TGBOUN 33.4 DEG.C	T05HTR 597.4 DEG.C
							T06HTR 601.3 DEG.C
							T07HTR 577.5 DEG.C
							T08HTR 604.4 DEG.C
HEAT TO COOLER	FLOCLR 4.16 L/MIN	CALCULATED PARAMETERS		VIBRATION		REMOTE CALCULATIONS	
		1 PWRIN 1821. WATTS		VX1HOR 0.2 CM/S		PWROUT 405. WATTS	T09HTR 598.5 DEG.C
		2 QCOOLR 987. WATTS		VY1VER 4.7 CM/S		INDPWR 424. WATTS	T10HTR 597.4 DEG.C
TWINCL 24.8 DEG.C		3 QDSHPT 272. WATTS				PISTST 1.99 CM	T11HTR 601.8 DEG.C
TDLCL 3.42 DEG.C		4 EXTEFF 22.3 %		PHASE ANGLES		DISPST 2.01 CM	
TWOCLR 28.77 DEG.C		5 TAVHTR 599.2 DEG.C		PADISP 80.8 DEG.			T13REG***** DEG.C
		6 INTEFF 29.1 %		PAPRES -20.9 DEG.			T14REG 509.0 DEG.C
		8 AMPS 910. AMPS		ENGINE SPEED		PAMPC 600. KPA	T15REG 377.1 DEG.C
		9 QDISPG 3. WATTS		FREQ 24.8 HZ		DISPCP 2.64 CM	T16REG***** DEG.C
		10 QDISP 15. WATTS				PISTCP 2.56 CM	T17REG 357.9 DEG.C
		11 QREG1 107. WATTS				PDYNDB 664. KPA	T18REG 352.6 DEG.C
		12 QREG2 127. WATTS				PDLCLR***** KPA	T19REG 220.9 DEG.C
		13 QREG3 36. WATTS				PDLREG***** KPA	
		14 PFP 599.7 KPA/CM				PDLDIS***** KPA	
		15 PFD 215.8 KPA/CM					T03HED***** DEG.C
		16 NBEALE 0.00800					

APPENDIX D. - CONTINUED.

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 01/16/84 14:07:19.44 RDG 864

FLUID HELIUM		BAROM 14.332 PSI		REGENERATOR 2	DISPLACER 2	STANDARD PISTON	
HEAT TO DASHPOT COOLING	FLODP	POWER IN		ENGINE CHARGE PRESSURE		GAS TEMPERATURES	SURFACE TEMPERATURES
FLODP	4.33 L/MIN	AMPS1	448. AMPS	PRESUP	4036. KPA	TGEXP 551.9 DEG.C	T01HTR 600.5 DEG.C
		AMPS2	504. AMPS				T02HTR 605.3 DEG.C
TWINDP	17.9 DEG.C	VOLTG	2.10 VOLTS	MEANBP	4009. KPA	TGREGH 541.5 DEG.C	T03HTR 604.0 DEG.C
TDLDP	0.99 DEG.C			MEANCP	4044. KPA	TGREGC 81.1 DEG.C	T04HTR 596.5 DEG.C
TWODPR	19.6 DEG.C					TGCOMP 39.2 DEG.C	T05HTR 597.8 DEG.C
						TGBOUN 33.5 DEG.C	T06HTR 601.2 DEG.C
							T07HTR 576.8 DEG.C
							T08HTR 603.4 DEG.C
							T09HTR 607.4 DEG.C
HEAT TO COOLER		CALCULATED PARAMETERS		VIBRATION		REMOTE CALCULATIONS	
FLOCCLR	4.17 L/MIN	1 PWRIN	1999. WATTS	VX1HOR	0.2 CM/S	PWRROUT	449. WATTS
TWINCL	24.8 DEG.C	2 QCOOLR	1111. WATTS	VY1VER	5.1 CM/S	INDPWR	471. WATTS
TDLCL	3.84 DEG.C	3 QDSHPT	299. WATTS			PISTST	2.15 CM
TWOCLR	29.15 DEG.C	4 EXTEFF	22.5 %	PHASE ANGLES		DISPST	2.12 CM
		5 TAVHTR	599.2 DEG.C	PADISP	81.0 DEG.		DYNAMIC CALCULATIONS
		6 INTEFF	28.8 %	PAPRES	-20.0 DEG.	PAMPC	640. KPA
		8 AMPS	953. AMPS			DISPCP	2.67 CM
		9 QDISPG	3. WATTS	ENGINE SPEED		PISTCP	2.58 CM
		10 QDISP	15. WATTS	FREQ	24.7 HZ	PDYNDB	738. KPA
		11 QREG1	107. WATTS			PDLCLR*****	KPA
		12 QREG2	126. WATTS			PDLREG*****	KPA
		13 QREG3	36. WATTS			PDLDIS*****	KPA
		14 PFP	592.3 KPA/CM				T03HED***** DEG.C
		15 PFD	209.2 KPA/CM				
		16 NBEALE	0.00821				

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 01/16/84 14:12:19.44 RDG 865

FLUID HELIUM		BAROM 14.332 PSI		REGENERATOR 2	DISPLACER 2	STANDARD PISTON	
HEAT TO DASHPOT COOLING	FLODP	POWER IN		ENGINE CHARGE PRESSURE		GAS TEMPERATURES	SURFACE TEMPERATURES
FLODP	4.34 L/MIN	AMPS1	479. AMPS	PRESUP	4040. KPA	TGEXP 550.7 DEG.C	T01HTR 601.4 DEG.C
		AMPS2	526. AMPS				T02HTR 605.3 DEG.C
TWINDP	17.9 DEG.C	VOLTG	2.21 VOLTS	MEANBP	4014. KPA	TGREGH 540.3 DEG.C	T03HTR 604.8 DEG.C
TDLDP	1.20 DEG.C			MEANCP	4053. KPA	TGREGC 82.5 DEG.C	T04HTR 596.0 DEG.C
TWODPR	19.7 DEG.C					TGCOMP 41.1 DEG.C	T05HTR 598.4 DEG.C
						TGBOUN 33.7 DEG.C	T06HTR 600.9 DEG.C
							T07HTR 576.5 DEG.C
							T08HTR 602.3 DEG.C
							T09HTR 608.6 DEG.C
HEAT TO COOLER		CALCULATED PARAMETERS		VIBRATION		REMOTE CALCULATIONS	
FLOCCLR	4.16 L/MIN	1 PWRIN	2225. WATTS	VX1HOR	0.3 CM/S	PWRROUT	516. WATTS
TWINCL	24.7 DEG.C	2 QCOOLR	1228. WATTS	VY1VER	5.6 CM/S	INDPWR	547. WATTS
TDLCL	4.25 DEG.C	3 QDSHPT	363. WATTS			PISTST	2.39 CM
TWOCLR	29.61 DEG.C	4 EXTEFF	23.2 %	PHASE ANGLES		DISPST	2.30 CM
		5 TAVHTR	599.4 DEG.C	PADISP	81.9 DEG.		DYNAMIC CALCULATIONS
		6 INTEFF	29.6 %	PAPRES	-18.8 DEG.	PAMPC	704. KPA
		8 AMPS	1005. AMPS			DISPCP	2.63 CM
		9 QDISPG	3. WATTS	ENGINE SPEED		PISTCP	2.61 CM
		10 QDISP	14. WATTS	FREQ	24.6 HZ	PDYNDB	807. KPA
		11 QREG1	104. WATTS			PDLCLR*****	KPA
		12 QREG2	127. WATTS			PDLREG*****	KPA
		13 QREG3	35. WATTS			PDLDIS*****	KPA
		14 PFP	583.6 KPA/CM				T03HED***** DEG.C
		15 PFD	199.7 KPA/CM				
		16 NBEALE	0.00849				

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 01/16/84 14:17:19.44 RDG 866

FLUID HELIUM		BAROM 14.332 PSI		REGENERATOR 2	DISPLACER 2	STANDARD PISTON	
HEAT TO DASHPOT COOLING	FLODP	POWER IN		ENGINE CHARGE PRESSURE		GAS TEMPERATURES	SURFACE TEMPERATURES
FLODP	4.33 L/MIN	AMPS1	500. AMPS	PRESUP	4055. KPA	TGEXP 549.3 DEG.C	T01HTR 602.6 DEG.C
		AMPS2	545. AMPS				T02HTR 606.2 DEG.C
TWINDP	17.9 DEG.C	VOLTG	2.30 VOLTS	MEANBP	4008. KPA	TGREGH 539.7 DEG.C	T03HTR 606.7 DEG.C
TDLDP	1.27 DEG.C			MEANCP	4049. KPA	TGREGC 84.1 DEG.C	T04HTR 596.4 DEG.C
TWODPR	19.8 DEG.C					TGCOMP 42.9 DEG.C	T05HTR 600.2 DEG.C
						TGBOUN 34.1 DEG.C	T06HTR 601.0 DEG.C
							T07HTR 577.2 DEG.C
							T08HTR 602.1 DEG.C
							T09HTR 610.3 DEG.C
HEAT TO COOLER		CALCULATED PARAMETERS		VIBRATION		REMOTE CALCULATIONS	
FLOCCLR	4.18 L/MIN	1 PWRIN	2408. WATTS	VX1HOR	0.3 CM/S	PWRROUT	572. WATTS
TWINCL	24.9 DEG.C	2 QCOOLR	1362. WATTS	VY1VER	6.0 CM/S	INDPWR	607. WATTS
TDLCL	4.70 DEG.C	3 QDSHPT	383. WATTS			PISTST	2.59 CM
TWOCLR	30.07 DEG.C	4 EXTEFF	23.8 %	PHASE ANGLES		DISPST	2.43 CM
		5 TAVHTR	600.3 DEG.C	PADISP	81.4 DEG.		DYNAMIC CALCULATIONS
		6 INTEFF	29.6 %	PAPRES	-18.3 DEG.	PAMPC	753. KPA
		8 AMPS	1045. AMPS			DISPCP	2.64 CM
		9 QDISPG	3. WATTS	ENGINE SPEED		PISTCP	2.63 CM
		10 QDISP	14. WATTS	FREQ	24.4 HZ	PDYNDB	850. KPA
		11 QREG1	102. WATTS			PDLCLR*****	KPA
		12 QPEG2	128. WATTS			PDLREG*****	KPA
		13 QREG3	35. WATTS			PDLDIS*****	KPA
		14 PFP	579.0 KPA/CM				T03HED***** DEG.C
		15 PFD	196.5 KPA/CM				
		16 NBEALE	0.00877				

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APPENDIX D. - CONTINUED.

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 01/16/84 14:22:19.44 RDG 867

FLUID HELIUM BAROM 14.332 PSI REGENERATOR 2 DISPLACER 2 STANDARD PISTON

HEAT TO DASHPOT COOLING FLODP 4.34 L/MIN	POWER IN AMPS1 526. AMPS AMPS2 563. AMPS VOLTG 2.40 VOLTS	ENGINE CHARGE PRESSURE PRESUP 4050. KPA	GAS TEMPERATURES TGEXP 545.6 DEG.C	SURFACE TEMPERATURES T01HTR 602.7 DEG.C T02HTR 604.9 DEG.C T03HTR 606.9 DEG.C T04HTR 595.0 DEG.C T05HTR 599.7 DEG.C T06HTR 599.9 DEG.C T07HTR 575.8 DEG.C T08HTR 600.1 DEG.C T09HTR 610.4 DEG.C T10HTR 601.5 DEG.C T11HTR 596.9 DEG.C T12HTR 599.7 DEG.C
TWINDP 17.9 DEG.C TDLDP 1.39 DEG.C TWODPR 20.0 DEG.C	MEANBP 3997. KPA MEANCP 4045. KPA	TGREGH 537.7 DEG.C TGREGC 85.7 DEG.C TGCOMP 45.2 DEG.C TGBOUN 34.8 DEG.C		
HEAT TO COOLER FLOC LR 4.17 L/MIN TWINCL 24.9 DEG.C TDLCL 5.21 DEG.C TWO CLR 30.65 DEG.C	CALCULATED PARAMETERS 1 PWRIIN 2617. WATTS 2 QCOOLR 1507. WATTS 3 QDSHPT 420. WATTS 4 EXTEFF 24.0 % 5 TAVHTR 599.5 DEG.C 6 INTEFF 29.4 % 8 AMPS 1090. AMPS 9 QDISPG 3. WATTS 10 QDISP 14. WATTS 11 QREG1 102. WATTS 12 QREG2 127. WATTS 13 QREG3 35. WATTS 14 PFP 583.2 KPA/CM 15 PFD 192.6 KPA/CM 16 NBEALE 0.00900	VIBRATION VXI HOR 0.3 CM/S VYI VER 6.5 CM/S PHASE ANGLES PADISP 81.5 DEG. PAPRES -17.4 DEG. ENGINE SPEED FREQ 24.3 HZ	REMOTE CALCULATIONS PUROUT 629. WATTS INDPWR 668. WATTS PISTST 2.80 CM DISPST 2.57 CM DYNAMIC CALCULATIONS PAMPC 817. KPA DISPCP 2.67 CM FISTCP 2.68 CM PDYMDB 888. KPA PDLCLR***** KPA PDLRREG***** KPA PDLDIS***** KPA	T13REG***** DEG.C T14REG 507.4 DEG.C T15REG 376.9 DEG.C T16REG***** DEG.C T17REG 356.9 DEG.C T18REG 350.4 DEG.C T19REG 225.2 DEG.C T03HED***** DEG.C

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 01/16/84 14:27:19.44 RDG 868

FLUID HELIUM BAROM 14.332 PSI REGENERATOR 2 DISPLACER 2 STANDARD PISTON

HEAT TO DASHPOT COOLING FLODP	4.34 L/MIN	POWER IN AMPS1 552. AMPS AMPS2 582. AMPS	ENGINE CHARGE PRESSURE PRESUP 4050. KPA	GAS TEMPERATURES TGEXP 542.4 DEG.C	SURFACE TEMPERATURES T01HTR 602.9 DEG.C T02HTR 603.4 DEG.C
TWINDP	17.9 DEG.C	VOLTG 2.50 VOLTS	MEANBP 3993. KPA	TGREGH 536.1 DEG.C	T03HTR 607.4 DEG.C
TDLDP	1.59 DEG.C		MEANCP 4043. KPA	TGREGC 87.5 DEG.C	T04HTR 593.6 DEG.C
TWODPR	20.2 DEG.C			TGCOMP 47.4 DEG.C	T05HTR 598.9 DEG.C
				TGBOUN 35.6 DEG.C	T06HTR 599.2 DEG.C
					T07HTR 574.0 DEG.C
					T08HTR 598.7 DEG.C

HEAT TO COOLER	CALCULATED PARAMETERS	VIBRATION	REMOTE CALCULATIONS	T09HTR
FLOCLR 4.17 L/MIN	1 PWRIN 2836. WATTS	VX1HOR 0.3 CM/S	PWROUT 683. WATTS	T10HTR 610.4 DEG.C
TWINCL 25.0 DEG.C	2 QCOOLR 1631. WATTS	VY1VER 6.9 CM/S	INDPWR 727. WATTS	T11HTR 596.2 DEG.C
TDLCL 5.64 DEG.C	3 QDSHPT 480. WATTS		PISTST 2.99 CM	T12HTR 597.9 DEG.C
TWOCLR 31.16 DEG.C	4 EXTEFF 24.1 %	PHASE ANGLES	DISPST 2.70 CM	
	5 TAVHTR 598.7 DEG.C	PADISP 82.0 DEG.		T13REG***** DEG.C
	6 INTEFF 29.5 %	PAPRES -16.6 DEG.	DYNAMIC CALCULATIONS	T14REG 504.7 DEG.C
	8 AMPS 1134. AMPS		PAMPC 866. KPA	T15REG 375.3 DEG.C
	9 QDISPG 3. WATTS	ENGINE SPEED	DISCP 2.73 CM	T16REG***** DEG.C
	10 QDISP 14. WATTS	FREQ 24.2 HZ	PISTCP 2.69 CM	T17REG 356.8 DEG.C
	11 QREG1 101. WATTS		PDYNDB 938. KPA	T18REG 350.9 DEG.C
	12 QREG2 125. WATTS		PDLCLR***** KPA	T19REG 225.8 DEG.C
	13 QREG3 35. WATTS		PDLREG***** KPA	
	14 PFP 577.9 KPA/CM		PDLDIS***** KPA	T03HED***** DEG.C
	15 PFD 184.9 KPA/CM			
	16 NBEALE 0.00918			

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003. REC 01/16/84 14:32:19.46 PDG 863

FLUID HELIUM BAROM 14.332 PSI REGENERATOR 2 DISPLACER 2 STANDARD PISTON

HEAT TO DASHPOT COOLING			POWER IN			ENGINE CHARGE PRESSURE			GAS TEMPERATURES			SURFACE TEMPERATURES		
FLODP	4.33	L/MIN	AMPS1	580.	AMPS	PRESUP	4043.	KPA	TGEXP	539.8	DEG.C	T01HTR	604.4	DEG.C
TWINDP	17.9	DEG.C	AMPS2	603.	AMPS	MEANBP	4004.	KPA	TGREGH	535.1	DEG.C	T02HTR	601.7	DEG.C
TDLDP	1.73	DEG.C	VOLTG	2.61	VOLTS	MEANCP	4058.	KPA	TGREGC	89.0	DEG.C	T03HTR	608.6	DEG.C
TWODPR	20.3	DEG.C				TGCOMP	50.1	DEG.C	T04HTR	591.6	DEG.C	T05HTR	597.9	DEG.C
						TGROJIN	36.7	DEG.C	T06HTR	599.1	DEG.C			

HEAT TO COOLER	CALCULATED PARAMETERS	VIBRATION	REMOTE CALCULATIONS	THERMAL
FLOCLR 4.18 L/MIN	1 PWRIN 3088. WATTS	VX1HOR 0.3 CM/S	PWRROUT 749. WATTS	T10HTR 603.4 DEG.C
TWINCL 25.1 DEG.C	2 QCOOLR 1814. WATTS	VY1VER 7.3 CM/S	INDPWR 797. WATTS	T11HTR 595.8 DEG.C
TDLCL 6.25 DEG.C	3 QDSHPT 522. WATTS		PISTST 3.17 CM	T12HTR 595.9 DEG.C
TWOCLR 31.89 DEG.C	4 EXTEFF 24.3 %	PHASE ANGLES	DISPST 2.74 CM	
	5 TAVHTR 598.1 DEG.C	PADISP 83.1 DEG.		T13REG***** DEG.C
	6 INTEFF 29.2 %	PAPRES -15.9 DEG.	DYNAMIC CALCULATIONS	T14REG 502.7 DEG.C
	8 AMPS 1183. AMPS		PAMPC 930. KPA	T15REG 374.4 DEG.C
	9 QDISPG 3. WATTS	ENGINE SPEED	DISPCP 2.80 CM	T16REG***** DEG.C
	10 QDISP 14. WATTS	FREQ 24.3 HZ	PISTCP 2.75 CM	T17REG 359.6 DEG.C
	11 QREG1 104. WATTS		PDYNDB 1013. KPA	T18REG 355.3 DEG.C
	12 QREG2 120. WATTS		PDLCLR***** KPA	T19REG 226.8 DEG.C
	13 QREG3 35. WATTS		PDLRREG***** KPA	
	14 PFP 583.7 KPA/CM		PDLDIS***** KPA	T03HED***** DEG.C
	15 PFD 187.4 KPA/CM			
	16 NREALE 0 00947			

APPENDIX D. - CONTINUED.

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 01/16/84 14:42:19.46 RDG 870

FLUID HELIUM		BAROM 14.332 PSI REGENERATOR 2 DISPLACER 2 STANDARD PISTON			
HEAT TO DASHPOT COOLING		POWER IN	ENGINE CHARGE PRESSURE	GAS TEMPERATURES	SURFACE TEMPERATURES
FLODP	4.31 L/MIN	AMPS1 470. AMPS	PRESUP 5524. KPA	TGEXP 560.7 DEG.C	T01HTR 598.8 DEG.C
TWINDP	17.9 DEG.C	AMPS2 519. AMPS	MEANBP 5492. KPA	TGREGH 542.5 DEG.C	T02HTR 607.4 DEG.C
TDLDP	1.23 DEG.C	VOLTG 2.18 VOLTS	MEANCN 5529. KPA	TGREGC 88.0 DEG.C	T03HTR 603.2 DEG.C
TWODPR	19.8 DEG.C			TGCOMP 40.3 DEG.C	T04HTR 597.9 DEG.C
				TGBOUN 35.2 DEG.C	T05HTR 597.0 DEG.C
					T06HTR 600.3 DEG.C
					T07HTR 576.4 DEG.C
					T08HTR 604.5 DEG.C
					T09HTR 608.9 DEG.C
HEAT TO COOLER		CALCULATED PARAMETERS	VIBRATION	REMOTE CALCULATIONS	T10HTR 597.6 DEG.C
FLOCLR	4.18 L/MIN	1 PWRIN 2152. WATTS	VX1HOR 0.2 CM/S	PWROUT 479. WATTS	T11HTR 596.7 DEG.C
TWINCL	25.0 DEG.C	2 QCOOLR 1268. WATTS	VY1VER 5.2 CM/S	INDPWR 513. WATTS	T12HTR 602.5 DEG.C
TDLCL	4.37 DEG.C	3 QDSHPT 368. WATTS		PISTST 1.78 CM	
TWOCLR	29.94 DEG.C	4 EXTEFF 22.3 %	PHASE ANGLES	DISPST 1.77 CM	
		5 TAVHTR 599.3 DEG.C	PADISP 80.8 DEG.		T13REG***** DEG.C
		6 INTEFF 27.4 %	PAPRES -19.9 DEG.		T14REG 508.9 DEG.C
		8 AMPS 989. AMPS		DYNAMIC CALCULATIONS	T15REG 376.9 DEG.C
		9 QDISPG 3. WATTS	ENGINE SPEED	PAMPC 733. KPA	T16REG***** DEG.C
		10 QDISP 15. WATTS	FREQ 28.8 HZ	DISPCP 2.60 CM	T17REG 357.0 DEG.C
		11 QREG1 103. WATTS		PISTCP 2.48 CM	T18REG 353.7 DEG.C
		12 QREG2 126. WATTS		PDYNDB 825. KPA	T19REG 226.2 DEG.C
		13 QREG3 35. WATTS		PDLCLP***** KPA	
		14 PFP 819.1 KPA/CM		PDLREG***** KPA	
		15 PFD 286.5 KPA/CM		PDLDIS***** KPA	
		16 NBEALE 0.00662			T03HED***** DEG.C

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 01/16/84 14:47:25.51 RDG 871

FLUID HELIUM		BAROM 14.332 PSI REGENERATOR 2 DISPLACER 2 STANDARD PISTON			
HEAT TO DASHPOT COOLING		POWER IN	ENGINE CHARGE PRESSURE	GAS TEMPERATURES	SURFACE TEMPERATURES
FLODP	4.30 L/MIN	AMPS1 508. AMPS	PRESUP 5533. KPA	TGEXP 557.4 DEG.C	T01HTR 599.0 DEG.C
TWINDP	18.0 DEG.C	AMPS2 548. AMPS	MEANBP 5503. KPA	TGREGH 540.7 DEG.C	T02HTR 606.3 DEG.C
TDLDP	1.42 DEG.C	VOLTG 2.33 VOLTS	MEANCN 5543. KPA	TGREGC 90.0 DEG.C	T03HTR 603.6 DEG.C
TWODPR	20.0 DEG.C			TGCOMP 42.5 DEG.C	T04HTR 596.4 DEG.C
				TGBOUN 35.2 DEG.C	T05HTR 596.6 DEG.C
					T06HTR 599.5 DEG.C
					T07HTR 574.2 DEG.C
					T08HTR 603.6 DEG.C
					T09HTR 609.2 DEG.C
HEAT TO COOLER		CALCULATED PARAMETERS	VIBRATION	REMOTE CALCULATIONS	T10HTR 597.7 DEG.C
FLOCLR	4.17 L/MIN	1 PWRIN 2455. WATTS	VX1HOR 0.2 CM/S	PWROUT 566. WATTS	T11HTR 596.6 DEG.C
TWINCL	24.9 DEG.C	2 QCOOLR 1427. WATTS	VY1VER 5.9 CM/S	INDPWR 604. WATTS	T12HTR 600.9 DEG.C
TDLCL	4.93 DEG.C	3 QDSHPT 425. WATTS		PISTST 1.99 CM	
TWOCLR	30.43 DEG.C	4 EXTEFF 23.0 %	PHASE ANGLES	DISPST 1.91 CM	
		5 TAVHTR 598.6 DEG.C	PADISP 82.0 DEG.		T13REG***** DEG.C
		6 INTEFF 28.4 %	PAPRES -18.9 DEG.		T14REG 506.5 DEG.C
		8 AMPS 1056. AMPS		DYNAMIC CALCULATIONS	T15REG 375.4 DEG.C
		9 QDISPG 3. WATTS	ENGINE SPEED	PAMPC 807. KPA	T16REG***** DEG.C
		10 QDISP 15. WATTS	FREQ 28.8 HZ	DISPCP 2.61 CM	T17REG 357.0 DEG.C
		11 QREG1 102. WATTS		PISTCP 2.51 CM	T18REG 352.1 DEG.C
		12 QREG2 125. WATTS		PDYNDB 913. KPA	T19REG 226.3 DEG.C
		13 QREG3 35. WATTS		PDLCLP***** KPA	
		14 PFP 805.7 KPA/CM		PDLREG***** KPA	
		15 PFD 276.0 KPA/CM		PDLDIS***** KPA	
		16 NBEALE 0.00699			T03HED***** DEG.C

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 01/16/84 14:52:19.51 RDG 872

FLUID HELIUM		BAROM 14.332 PSI REGENERATOR 2 DISPLACER 2 STANDARD PISTON			
HEAT TO DASHPOT COOLING		POWER IN	ENGINE CHARGE PRESSURE	GAS TEMPERATURES	SURFACE TEMPERATURES
FLODP	4.33 L/MIN	AMPS1 544. AMPS	PRESUP 5918. KPA	TGEXP 555.5 DEG.C	T01HTR 600.6 DEG.C
TWINDP	18.0 DEG.C	AMPS2 576. AMPS	MEANBP 5502. KPA	TGREGH 539.7 DEG.C	T02HTR 606.9 DEG.C
TDLDP	1.54 DEG.C	VOLTG 2.47 VOLTS	MEANCN 5549. KPA	TGREGC 91.9 DEG.C	T03HTR 606.2 DEG.C
TWODPR	20.2 DEG.C			TGCOMP 45.1 DEG.C	T04HTR 596.3 DEG.C
				TGBOUN 35.5 DEG.C	T05HTR 597.6 DEG.C
					T06HTR 599.9 DEG.C
					T07HTR 573.6 DEG.C
					T08HTR 603.6 DEG.C
					T09HTR 610.7 DEG.C
HEAT TO COOLER		CALCULATED PARAMETERS	VIBRATION	REMOTE CALCULATIONS	T10HTR 599.5 DEG.C
FLOCLR	4.16 L/MIN	1 PWRIN 2767. WATTS	VX1HOR 0.3 CM/S	PWROUT 654. WATTS	T11HTR 597.3 DEG.C
TWINCL	24.9 DEG.C	2 QCOOLR 1625. WATTS	VY1VER 6.6 CM/S	INDPWR 694. WATTS	T12HTR 601.3 DEG.C
TDLCL	5.63 DEG.C	3 QDSHPT 465. WATTS		PISTST 2.19 CM	
TWOCLR	31.12 DEG.C	4 EXTEFF 23.6 %	PHASE ANGLES	DISPST 2.05 CM	
		5 TAVHTR 599.4 DEG.C	PADISP 83.0 DEG.		T13REG***** DEG.C
		6 INTEFF 28.7 %	PAPRES -17.9 DEG.		T14REG 506.2 DEG.C
		8 AMPS 1120. AMPS		DYNAMIC CALCULATIONS	T15REG 375.3 DEG.C
		9 QDISPG 3. WATTS	ENGINE SPEED	PAMPC 901. KPA	T16REG***** DEG.C
		10 QDISP 14. WATTS	FREQ 28.8 HZ	DISPCP 2.65 CM	T17REG 358.2 DEG.C
		11 QREG1 103. WATTS		PISTCP 2.53 CM	T18REG 354.7 DEG.C
		12 QREG2 123. WATTS		PDYNDB 1000. KPA	T19REG 228.1 DEG.C
		13 QREG3 35. WATTS		PDLCLP***** KPA	
		14 PFP 813.2 KPA/CM		PDLREG***** KPA	
		15 PFD 272.7 KPA/CM		PDLDIS***** KPA	
		16 NBEALE 0.00733			T03HED***** DEG.C

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APPENDIX D. - CONTINUED.

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 01/16/84 14:57:19.51 RDG 873

FLUID HELIUM BAROM 14.332 PSI REGENERATOR 2 DISPLACER 2 STANDARD PISTON

HEAT TO DASHPOT COOLING		POWER IN	ENGINE CHARGE PRESSURE	GAS TEMPERATURES	SURFACE TEMPERATURES
FLODP	4.32 L/MIN	AMPS1 579. AMPS	PRESUP 5700. KPA	TGEXP 553.0 DEG.C	T01HTR 601.3 DEG.C
		AMPS2 601. AMPS			T02HTR 606.6 DEG.C
TWINDP	18.0 DEG.C	VOLTG 2.60 VOLTS	MEANBP 5504. KPA	TGREGH 538.3 DEG.C	T03HTR 607.7 DEG.C
TDLDP	1.74 DEG.C		MEANCN 5553. KPA	TGREGC 93.4 DEG.C	T04HTR 595.5 DEG.C
TWODPR	20.4 DEG.C			TGCOMP 47.8 DEG.C	T05HTR 597.8 DEG.C
				TGBOUN 36.2 DEG.C	T06HTR 599.6 DEG.C
					T07HTR 572.5 DEG.C
					T08HTR 603.0 DEG.C
					T09HTR 611.2 DEG.C
HEAT TO COOLER		CALCULATED PARAMETERS	VIBRATION	REMOTE CALCULATIONS	
FLOCRL	4.20 L/MIN	1 PWRIN 3068. WATTS	VX1HOR 0.3 CM/S	PWRROUT 735. WATTS	T10HTR 600.4 DEG.C
TWINCL	25.1 DEG.C	2 QCOOLR 1834. WATTS	VY1VER 7.2 CM/S	INDPWR 780. WATTS	T11HTR 597.3 DEG.C
TDLCL	6.30 DEG.C	3 QDSHPT 522. WATTS		PISTST 2.39 CM	T12HTR 601.1 DEG.C
TWOCLR	31.83 DEG.C	4 EXTEFF 24.0 %	PHASE ANGLES	DISPST 2.17 CM	
		5 TAVHTR 599.5 DEG.C	PADISP 83.7 DEG.		T13REG***** DEG.C
		6 INTEFF 28.6 %	PAPRES -16.9 DEG.		T14REG 505.8 DEG.C
		8 AMPS 1180. AMPS		DYNAMIC CALCULATIONS	T15REG 373.5 DEG.C
		9 QDISPG 3. WATTS	ENGINE SPEED	PAMPC 974. KPA	T16REG***** DEG.C
		10 QDISP 14. WATTS	FREQ 28.7 HZ	DISPCP 2.69 CM	
		11 QREG1 103. WATTS		PISTCP 2.57 CM	T17REG 359.0 DEG.C
		12 QREG2 121. WATTS		PDYNDB 1088. KPA	T18REG 356.5 DEG.C
		13 QREG3 34. WATTS		PDLCLR***** KPA	T19REG 229.0 DEG.C
		14 PFP 805.5 KPA/CM		PDLREG***** KPA	
		15 PFD 262.4 KPA/CM		PDLDIS***** KPA	T03HED***** DEG.C
		16 NBEALE 0.00756			

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 01/16/84 15:02:19.51 RDG 874

FLUID HELIUM BAROM 14.332 PSI REGENERATOR 2 DISPLACER 2 STANDARD PISTON

HEAT TO DASHPOT COOLING		POWER IN	ENGINE CHARGE PRESSURE	GAS TEMPERATURES	SURFACE TEMPERATURES
FLODP	4.29 L/MIN	AMPS1 615. AMPS	PRESUP 5643. KPA	TGEXP 549.9 DEG.C	T01HTR 601.5 DEG.C
		AMPS2 629. AMPS			T02HTR 605.9 DEG.C
TWINDP	18.0 DEG.C	VOLTG 2.74 VOLTS	MEANBP 5508. KPA	TGREGH 535.7 DEG.C	T03HTR 608.8 DEG.C
TDLDP	1.97 DEG.C		MEANCN 5565. KPA	TGREGC 96.1 DEG.C	T04HTR 594.5 DEG.C
TWODPR	20.6 DEG.C			TGCOMP 50.8 DEG.C	T05HTR 598.1 DEG.C
				TGBOUN 37.1 DEG.C	T06HTR 598.8 DEG.C
					T07HTR 571.0 DEG.C
					T08HTR 601.4 DEG.C
HEAT TO COOLER		CALCULATED PARAMETERS	VIBRATION	REMOTE CALCULATIONS	
FLOCRL	4.20 L/MIN	1 PWRIN 3407. WATTS	VX1HOR 0.3 CM/S	PWRROUT 817. WATTS	T10HTR 600.8 DEG.C
TWINCL	25.1 DEG.C	2 QCCOLR 2041. WATTS	VY1VER 7.9 CM/S	INDPWR 868. WATTS	T11HTR 596.3 DEG.C
TDLCL	7.01 DEG.C	3 QDSHPT 588. WATTS		PISTST 2.61 CM	T12HTR 600.1 DEG.C
TWOCLR	32.72 DEG.C	4 EXTEFF 24.0 %	PHASE ANGLES	DISPST 2.31 CM	
		5 TAVHTR 599.1 DEG.C	PADISP 84.2 DEG.		T13REG***** DEG.C
		6 INTEFF 28.6 %	PAPRES -15.9 DEG.	DYNAMIC CALCULATIONS	T14REG 505.0 DEG.C
		8 AMPS 1243. AMPS		PAMFC 1063. KPA	T15REG 374.9 DEG.C
		9 QDISPG 3. WATTS	ENGINE SPEED	DISPCP 2.71 CM	T16REG***** DEG.C
		10 QDISP 14. WATTS	FREQ 28.7 HZ	PISTCP 2.58 CM	T17REG 359.3 DEG.C
		11 QREG1 102. WATTS		PDYNDB 1138. KPA	T18REG 357.7 DEG.C
		12 QREG2 119. WATTS		PDLCLR***** KPA	T19REG 232.3 DEG.C
		13 QREG3 34. WATTS		PDLREG***** KPA	
		14 PFP 807.0 KPA/CM		PDLDIS***** KPA	T03HED***** DEG.C
		15 PFD 253.5 KPA/CM			
		16 NBEALE 0.00773			

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 01/16/84 15:07:19.52 RDG 875

FLUID HELIUM BAROM 14.332 PSI REGENERATOR 2 DISPLACER 2 STANDARD PISTON

HEAT TO DASHPOT COOLING		POWER IN	ENGINE CHARGE PRESSURE	GAS TEMPERATURES	SURFACE TEMPERATURES
FLODP	4.30 L/MIN	AMPS1 649. AMPS	PRESUP 5623. KPA	TGEXP 547.9 DEG.C	T01HTR 602.4 DEG.C
		AMPS2 651. AMPS			T02HTR 606.0 DEG.C
TWINDP	18.0 DEG.C	VOLTG 2.86 VOLTS	MEANBP 5500. KPA	TGREGH 535.2 DEG.C	T03HTR 610.2 DEG.C
TDLDP	2.18 DEG.C		MEANCN 5562. KPA	TGREGC 98.1 DEG.C	T04HTR 594.5 DEG.C
TWODPR	20.8 DEG.C			TGCOMP 54.0 DEG.C	T05HTR 599.1 DEG.C
				TGBOUN 38.5 DEG.C	T06HTR 599.1 DEG.C
					T07HTR 570.5 DEG.C
					T08HTR 601.9 DEG.C
					T09HTR 613.4 DEG.C
HEAT TO COOLER		CALCULATED PARAMETERS	VIBRATION	REMOTE CALCULATIONS	
FLOCRL	4.19 L/MIN	1 PWRIN 3721. WATTS	VX1HOR 0.3 CM/S	PWRROUT 893. WATTS	T10HTR 601.8 DEG.C
TWINCL	25.2 DEG.C	2 QCCOLR 2244. WATTS	VY1VER 8.5 CM/S	INDPWR 947. WATTS	T11HTR 597.3 DEG.C
TDLCL	7.72 DEG.C	3 QDSHPT 652. WATTS		PISTST 2.79 CM	T12HTR 600.4 DEG.C
TWOCLR	33.35 DEG.C	4 EXTEFF 24.0 %	PHASE ANGLES	DISPST 2.43 CM	
		5 TAVHTR 599.7 DEG.C	PADISP 84.1 DEG.		T13REG***** DEG.C
		6 INTEFF 28.5 %	PAPRES -15.3 DEG.	DYNAMIC CALCULATIONS	T14REG 505.3 DEG.C
		8 AMPS 1301. AMPS		PAMPC 1142. KPA	T15REG 376.4 DEG.C
		9 QDISPG 3. WATTS	ENGINE SPEED	DISPCP 2.74 CM	T16REG***** DEG.C
		10 QDISP 14. WATTS	FREQ 28.6 HZ	PISTCP 2.59 CM	T17REG 359.4 DEG.C
		11 QREG1 100. WATTS		PDYNDB 1225. KPA	T18REG 357.9 DEG.C
		12 QREG2 120. WATTS		PDLCLR***** KPA	T19REG 234.3 DEG.C
		13 QREG3 34. WATTS		PDLREG***** KPA	
		14 PFP 811.8 KPA/CM		PDLDIS***** KPA	T03HED***** DEG.C
		15 PFD 249.2 KPA/CM			
		16 NBEALE 0.00793			

APPENDIX D. - CONTINUED.

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 01/16/84 15:12:19.57 RDG 876

FLUID HELIUM BAROM 14.332 PSI REGENERATOR 2 DISPLACER 2 STANDARD PISTON

HEAT TO DASHPOT COOLING	POWER IN	ENGINE CHARGE PRESSURE	GAS TEMPERATURES	SURFACE TEMPERATURES
FLODP 4.29 L/MIN	AMPS1 678. AMPS AMPS2 673. AMPS	PRESUP 5655. KPA	TGEXP 544.3 DEG.C	T01HTR 603.1 DEG.C T02HTR 604.9 DEG.C
TWINDP 18.0 DEG.C	VOLTG 2.97 VOLTS	MEANBP 5515. KPA	TGREGH 534.2 DEG.C	T03HTR 610.5 DEG.C T04HTR 593.5 DEG.C
TDLDP 2.44 DEG.C		MEANCOP 5587. KPA	TGREGC 101.1 DEG.C	T05HTR 598.7 DEG.C
TWODPR 21.1 DEG.C			TGCOMP 57.5 DEG.C	T06HTR 598.3 DEG.C
			TGBOUN 39.8 DEG.C	T07HTR 569.2 DEG.C T08HTR 601.1 DEG.C
				T09HTR 614.2 DEG.C
HEAT TO COOLER	CALCULATED PARAMETERS	VIBRATION	REMOTE CALCULATIONS	T10HTR 602.4 DEG.C
FLOCRL 4.20 L/MIN	1 PWRIM 4017. WATTS 2 QCOOLR 2473. WATTS 3 QDSHPT 729. WATTS 4 EXTEFF 24.0 % 5 TAVHTR 599.3 DEG.C 6 INTEFF 28.1 % 8 AMPS 1351. AMPS 9 QDISPG 3. WATTS 10 QDISP 14. WATTS 11 QREG1 100. WATTS 12 QREG2 117. WATTS 13 QREG3 34. WATTS 14 PFP 809.8 KPA/CM 15 PFD 240.9 KPA/CM 16 NBEALE 0.00802	VX1HOR 0.4 CM/S VY1VER 9.0 CM/S	PWRROUT 965. WATTS INDPW 1019. WATTS PISTST 2.99 CM DISPST 2.55 CM	T11HTR 597.6 DEG.C T12HTR 598.7 DEG.C
TWINCL 25.2 DEG.C		PHASE ANGLES	DYNAMIC CALCULATIONS	T13REG***** DEG.C
TDLCL 8.49 DEG.C		PADISP 82.7 DEG. PAPRES -14.6 DEG.	PAMPC 1211. KPA	T14PEG 503.6 DEG.C
TWOCLR 34.20 DEG.C		ENGINE SPEED	DISPPC 2.79 CM	T15REG 375.5 DEG.C
		FREQ 28.4 HZ	PISTCP 2.56 CM	T16REG***** DEG.C
			PDYNDB 1263. KPA	T17REG 363.4 DEG.C
			PDLCLR***** KPA	T18REG 359.0 DEG.C
			PDLREG***** KPA	T19REG 235.8 DEG.C
			PDLDIS***** KPA	T03HED***** DEG.C

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 01/16/84 15:17:19.57 RDG 877

FLUID HELIUM BAROM 14.332 PSI REGENERATOR 2 DISPLACER 2 STANDARD PISTON

HEAT TO DASHPOT COOLING	POWER IN	ENGINE CHARGE PRESSURE	GAS TEMPERATURES	SURFACE TEMPERATURES
FLODP 4.27 L/MIN	AMPS1 710. AMPS AMPS2 698. AMPS	PRESUP 5643. KPA	TGEXP 541.6 DEG.C	T01HTR 605.2 DEG.C T02HTR 602.6 DEG.C
TWINDP 18.0 DEG.C	VOLTG 3.10 VOLTS	MEANBP 5502. KPA	TGREGH 534.2 DEG.C	T03HTR 611.6 DEG.C
TDLDP 2.67 DEG.C		MEANCOP 5583. KPA	TGREGC 104.1 DEG.C	T04HTR 591.6 DEG.C
TWODPR 21.4 DEG.C			TGCOMP 60.3 DEG.C	T05HTR 596.5 DEG.C
			TGBOUN 41.3 DEG.C	T06HTR 599.2 DEG.C T07HTR 565.8 DEG.C
				T08HTR 601.7 DEG.C T09HTR 613.7 DEG.C
HEAT TO COOLER	CALCULATED PARAMETERS	VIBRATION	REMOTE CALCULATIONS	T10HTR 604.1 DEG.C
FLOCRL 4.21 L/MIN	1 PWPIN 4369. WATTS 2 QCOOLR 2740. WATTS 3 QDSHPT 792. WATTS 4 EXTEFF 24.0 % 5 TAVHTR 598.9 DEG.C 6 INTEFF 27.7 % 8 AMPS 1408. AMPS 9 QDISPG 3. WATTS 10 QDISP 14. WATTS 11 QREG1 104. WATTS 12 QREG2 111. WATTS 13 QREG3 33. WATTS 14 PFP 811.9 KPA/CM 15 PFD 240.9 KPA/CM 16 NBEALE 0.00817	VX1HOR 0.4 CM/S VY1VER 9.7 CM/S	PWRROUT 1049. WATTS INDPW 1101. WATTS PISTST 3.20 CM DISPST 2.58 CM	T11HTR 598.4 DEG.C T12HTR 596.9 DEG.C
TWINCL 25.3 DEG.C		PHASE ANGLES	DYNAMIC CALCULATIONS	T13REG***** DEG.C
TDLCL 9.38 DEG.C		PADISP 84.0 DEG. PAPRES -13.7 DEG.	PAMPC 1304. KPA	T14REG 499.6 DEG.C
TWOCLR 35.17 DEG.C		ENGINE SPEED	DISPPC 2.83 CM	T15REG 371.9 DEG.C
		FREQ 28.4 HZ	PISTCP 2.53 CM	T16REG***** DEG.C
			PDYNDB 1338. KPA	T17REG 367.7 DEG.C
			PDLCLR***** KPA	T18REG 363.3 DEG.C
			PDLREG***** KPA	T19REG 235.4 DEG.C
			PDLDIS***** KPA	T03HED***** DEG.C

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 01/16/84 15:22:19.57 RDG 878

FLUID HELIUM BAROM 14.332 PSI REGENERATOR 2 DISPLACER 2 STANDARD PISTON

HEAT TO DASHPOT COOLING	POWER IN	ENGINE CHARGE PRESSURE	GAS TEMPERATURES	SURFACE TEMPERATURES
FLODP 4.26 L/MIN	AMPS1 739. AMPS AMPS2 720. AMPS	PRESUP 5619. KPA	TGEXP 540.1 DEG.C	T01HTR 606.6 DEG.C T02HTR 603.3 DEG.C
TWINDP 17.9 DEG.C	VOLTG 3.22 VOLTS	MEANBP 5511. KPA	TGREGH 533.9 DEG.C	T03HTR 613.5 DEG.C
TDLDP 2.93 DEG.C		MEANCOP 5595. KPA	TGREGC 106.2 DEG.C	T04HTR 591.7 DEG.C
TWODPR 21.6 DEG.C			TGCOMP 63.7 DEG.C	T05HTR 598.5 DEG.C
			TGBOUN 42.5 DEG.C	T06HTR 599.9 DEG.C T07HTR 565.4 DEG.C
				T08HTR 602.5 DEG.C T09HTR 615.0 DEG.C
HEAT TO COOLER	CALCULATED PARAMETERS	VIBRATION	REMOTE CALCULATIONS	T10HTR 605.5 DEG.C
FLOCRL 4.23 L/MIN	1 PWPIN 4694. WATTS 2 QCOOLR 3002. WATTS 3 QDSHPT 869. WATTS 4 EXTEFF 23.7 % 5 TAVHTR 599.9 DEG.C 6 INTEFF 27.0 % 8 AMPS 1458. AMPS 9 QDISPG 3. WATTS 10 QDISP 14. WATTS 11 QREG1 102. WATTS 12 QREG2 111. WATTS 13 QREG3 33. WATTS 14 PFP 817.9 KPA/CM 15 PFD 240.5 KPA/CM 16 NBEALE 0.00817	VX1HOR 0.3 CM/S VY1VER 10.2 CM/S	PWRROUT 1112. WATTS INDPW 1165. WATTS PISTST 3.39 CM DISPST 2.62 CM	T11HTR 599.4 DEG.C T12HTR 597.7 DEG.C
TWINCL 25.2 DEG.C		PHASE ANGLES	DYNAMIC CALCULATIONS	T13REG***** DEG.C
TDLCL 10.22 DEG.C		PADISP 84.6 DEG. PAPRES -13.0 DEG.	PAMPC 1393. KPA	T14REG 501.2 DEG.C
TWOCLR 35.97 DEG.C		ENGINE SPEED	DISPPC 2.81 CM	T15REG 374.4 DEG.C
		FREQ 28.3 HZ	PISTCP 2.58 CM	T16REG***** DEG.C
			PDYNDB 1425. KPA	T17REG 368.3 DEG.C
			PDLCLR***** KPA	T18REG 364.4 DEG.C
			PDLREG***** KPA	T19REG 238.5 DEG.C
			PDLDIS***** KPA	T03HED***** DEG.C

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APPENDIX D. - CONTINUED.

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 01/19/84 12:35:29.83 RDG 909

FLUID HELIUM		BAROM 14.450 PSI		REGENERATOR 2	DISPLACER 2	STANDARD PISTON		
HEAT TO DASHPOT COOLING	FLODP 4.11 L/MIN	POWER IN		ENGINE CHARGE PRESSURE		GAS TEMPERATURES	SURFACE TEMPERATURES	
		AMPS1 520. AMPS		PRESUP 7093. KPA		TGEXP 420.9 DEG.C	T01HTR 450.9 DEG.C	
		AMPS2 521. AMPS				TGREGH 402.3 DEG.C	T02HTR 456.7 DEG.C	
TWINDP 17.4 DEG.C		VOLTG 2.25 VOLTS		MEANBP 7011. KPA		TGREGC 80.3 DEG.C	T03HTR 458.1 DEG.C	
TDLDP 1.22 DEG.C				MEANCP 7039. KPA		TGCOMP 43.3 DEG.C	T04HTR 448.1 DEG.C	
TWODPR 19.2 DEG.C						TGBOUN 32.5 DEG.C	T05HTR 445.7 DEG.C	
							T06HTR 452.8 DEG.C	
							T07HTR 423.7 DEG.C	
							T08HTR 455.8 DEG.C	
							T09HTR 459.0 DEG.C	
HEAT TO COOLER	FLOCRL 4.14 L/MIN	CALCULATED PARAMETERS		VIBRATION		REMOTE CALCULATIONS	SURFACE TEMPERATURES	
		1 PWRIN 2338. WATTS		VX1HOR 0.3 CM/S		PWRROUT 463. WATTS	T10HTR 450.0 DEG.C	
		2 QCOOLR 1518. WATTS		VY1VER 6.2 CM/S		INDPWR 461. WATTS	T11HTR 447.1 DEG.C	
		3 QDSHPT 350. WATTS				PISTST 1.80 CM	T12HTR 454.2 DEG.C	
		4 EXTEFF 19.8 %				DISPST 1.68 CM		
		5 TAVHTR 450.2 DEG.C		PHASE ANGLES		DYNAMIC CALCULATIONS	T13PEG***** DEG.C	
		6 INTEFF 23.4 %		PADISP 87.6 DEG.		PAMPC 910. KPA	T14REG 377.6 DEG.C	
		8 AMPS 1041. AMPS		PAPRES -13.1 DEG.		DISPCP 2.60 CM	T15REG 281.7 DEG.C	
		9 QDISPG 2. WATTS		ENGINE SPEED		PISTCP 2.36 CM	T16REG***** DEG.C	
		10 QDISP 11. WATTS		FREQ 31.6 HZ		PDYNDB 1063. KPA	T17REG 273.9 DEG.C	
		11 QREG1 84. WATTS				PDLCLR***** KPA	T18REG 283.1 DEG.C	
		12 QREG2 77. WATTS				PDLREG***** KPA	T19REG 179.1 DEG.C	
		13 QREG3 25. WATTS				PDLDIS***** KPA		
		14 PFP 993.5 KPA/CM					T03HED***** DEG.C	
		15 PFD 245.7 KPA/CM						
		16 NBEALE 0.00452						

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 01/19/84 12:40:20.83 RDG 910

FLUID HELIUM		BAROM 14.445 PSI		REGENERATOR 2	DISPLACER 2	STANDARD PISTON		
HEAT TO DASHPOT COOLING	FLODP 4.10 L/MIN	POWER IN		ENGINE CHARGE PRESSURE		GAS TEMPERATURES	SURFACE TEMPERATURES	
		AMPS1 556. AMPS		PRESUP 7096. KPA		TGEXP 418.9 DEG.C	T01HTR 450.2 DEG.C	
		AMPS2 547. AMPS				TGREGH 399.9 DEG.C	T02HTR 456.6 DEG.C	
TWINDP 17.3 DEG.C		VOLTG 2.38 VOLTS		MEANBP 6998. KPA		TGREGC 82.9 DEG.C	T03HTR 457.9 DEG.C	
TDLDP 1.41 DEG.C				MEANCP 7032. KPA		TGCOMP 45.9 DEG.C	T04HTR 447.5 DEG.C	
TWODPR 19.4 DEG.C						TGBOUN 32.9 DEG.C	T05HTR 445.7 DEG.C	
							T06HTR 451.7 DEG.C	
							T07HTR 422.6 DEG.C	
							T08HTR 454.9 DEG.C	
							T09HTR 459.7 DEG.C	
HEAT TO COOLER	FLOCRL 4.16 L/MIN	CALCULATED PARAMETERS		VIBRATION		REMOTE CALCULATIONS	T10HTR 449.3 DEG.C	
		1 PWRIN 2625. WATTS		VX1HOR 0.3 CM/S		PWRROUT 520. WATTS	T11HTR 446.4 DEG.C	
		2 QCOOLR 1723. WATTS		VY1VER 6.9 CM/S		INDPWR 517. WATTS	T12HTR 453.6 DEG.C	
		3 QDSHPT 402. WATTS				PISTST 2.00 CM		
		4 EXTEFF 19.8 %		PHASE ANGLES		DISPST 1.78 CM		
		5 TAVHTR 449.7 DEG.C		PADISP 88.3 DEG.		DYNAMIC CALCULATIONS	T13REG***** DEG.C	
		6 INTEFF 23.2 %		PAPRES -12.0 DEG.		PAMPC 1009. KPA	T14REG 377.0 DEG.C	
		8 AMPS 1103. AMPS		ENGINE SPEED		DISPCP 2.60 CM	T15REG 282.7 DEG.C	
		9 QDISPG 2. WATTS		FREQ 31.5 HZ		PISTCP 2.38 CM	T16REG***** DEG.C	
		10 QDISP 11. WATTS				PDYNDB 1125. KPA	T17REG 273.5 DEG.C	
		11 QREG1 82. WATTS				PDLCLR***** KPA	T18REG 282.3 DEG.C	
		12 QREG2 77. WATTS				PDLREG***** KPA	T19REG 181.6 DEG.C	
		13 QREG3 25. WATTS				PDLDIS***** KPA		
		14 PFP 993.8 KPA/CM					T03HED***** DEG.C	
		15 PFD 235.5 KPA/CM						
		16 NBEALE 0.00460						

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 01/19/84 12:45:23.83 RDG 911

FLUID HELIUM		BAROM 14.445 PSI		REGENERATOR 2	DISPLACER 2	STANDARD PISTON		
HEAT TO DASHPOT COOLING	FLODP 4.09 L/MIN	POWER IN		ENGINE CHARGE PRESSURE		GAS TEMPERATURES	SURFACE TEMPERATURES	
		AMPS1 591. AMPS		PRESUP 7094. KPA		TGEXP 417.1 DEG.C	T01HTR 450.2 DEG.C	
		AMPS2 574. AMPS				TGREGH 398.5 DEG.C	T02HTR 457.2 DEG.C	
TWINDP 17.0 DEG.C		VOLTG 2.51 VOLTS		MEANBP 6999. KPA		TGREGC 85.7 DEG.C	T03HTR 458.6 DEG.C	
TDLDP 1.59 DEG.C				MEANCP 7031. KPA		TGCOMP 49.0 DEG.C	T04HTR 447.3 DEG.C	
TWODPR 19.2 DEG.C						TGBOUN 33.5 DEG.C	T05HTR 447.2 DEG.C	
							T06HTR 451.7 DEG.C	
							T07HTR 421.8 DEG.C	
							T08HTR 455.0 DEG.C	
HEAT TO COOLER	FLOCRL 4.16 L/MIN	CALCULATED PARAMETERS		VIBRATION		REMOTE CALCULATIONS	T09HTR 461.0 DEG.C	
		1 PWRIN 2928. WATTS		VX1HOR 0.3 CM/S		PWRROUT 573. WATTS	T10HTR 449.9 DEG.C	
		2 QCOOLR 1933. WATTS		VY1VER 7.6 CM/S		INDPWR 567. WATTS	T11HTR 446.7 DEG.C	
		3 QDSHPT 452. WATTS				PISTST 2.20 CM	T12HTR 453.8 DEG.C	
		4 EXTEFF 19.6 %		PHASE ANGLES		DISPST 1.89 CM		
		5 TAVHTR 450.1 DEG.C		PADISP 88.6 DEG.		DYNAMIC CALCULATIONS	T13REG***** DEG.C	
		6 INTEFF 22.9 %		PAPRES -11.1 DEG.		PAMPC 1102. KPA	T14REG 377.4 DEG.C	
		8 AMPS 1164. AMPS		ENGINE SPEED		DISPCP 2.60 CM	T15REG 284.3 DEG.C	
		9 QDISPG 2. WATTS		FREQ 31.4 HZ		PISTCP 2.38 CM	T16REG***** DEG.C	
		10 QDISP 10. WATTS				PDYNDB 1213. KPA	T17REG 274.7 DEG.C	
		11 QREG1 79. WATTS				PDLCLR***** KPA	T18REG 281.6 DEG.C	
		12 QREG2 78. WATTS				PDLREG***** KPA	T19REG 184.2 DEG.C	
		13 QREG3 24. WATTS				PDLDIS***** KPA		
		14 PFP 990.0 KPA/CM					T03HED***** DEG.C	
		15 PFD 224.5 KPA/CM						
		16 NBEALE 0.00462						

APPENDIX D. - CONTINUED.

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 01/19/84 12:50:20.83 RDG 912

FLUID HELIUM		BAROM 14.445 PSI		REGENERATOR 2	DISPLACER 2	STANDARD PISTON	
HEAT TO DASHPOT COOLING	FLODP 4.08 L/MIN	POWER IN		ENGINE CHARGE PRESSURE		GAS TEMPERATURES	SURFACE TEMPERATURES
		AMPS1 625. AMPS		PRESUP 7102. KPA		TGEXP 414.5 DEG.C	T01HTR 450.9 DEG.C
		AMPS2 603. AMPS					T02HTR 456.8 DEG.C
		VOLTG 2.65 VOLTS		MEANBP 7012. KPA		TGREGH 396.7 DEG.C	T03HTR 458.8 DEG.C
				MEANCP 7050. KPA		TGREGC 88.6 DEG.C	T04HTR 446.5 DEG.C
						TGCOMP 52.4 DEG.C	T05HTR 446.9 DEG.C
						TGBOUN 34.1 DEG.C	T06HTR 451.1 DEG.C
							T07HTR 420.2 DEG.C
							T08HTR 454.5 DEG.C
							T09HTR 461.6 DEG.C
							T10HTR 450.1 DEG.C
HEAT TO COOLER	FLOCRL 4.15 L/MIN	CALCULATED PARAMETERS		VIBRATION		REMOTE CALCULATIONS	T11HTR 446.4 DEG.C
	TWINCL 25.4 DEG.C	1 PWRIN 3251. WATTS		VX1HOR 0.4 CM/S		PWRROUT 618. WATTS	T12HTR 453.1 DEG.C
	TDLCL 7.57 DEG.C	2 QCOOLR 2181. WATTS		VY1VER 8.2 CM/S		INDPWR 619. WATTS	
	TWOCLR 33.08 DEG.C	3 QDSHPT 491. WATTS				PISTST 2.40 CM	
		4 EXTEFF 19.0 %		PHASE ANGLES		DISPST 2.00 CM	
		5 TAVHTR 449.7 DEG.C		PADISP 88.7 DEG.			T13REG***** DEG.C
		6 INTEFF 22.1 %		PAPRES -10.3 DEG.			T14REG 376.0 DEG.C
		8 AMPS 1227. AMPS				DYNAMIC CALCULATIONS	T15REG 284.5 DEG.C
		9 QDISPG 2. WATTS		ENGINE SPEED		PAMPC 1153. KPA	T16REG***** DEG.C
		10 QDISP 10. WATTS		FREQ 31.3 HZ		DISPCP 2.61 CM	T17REG 273.5 DEG.C
		11 QREG1 78. WATTS				PISTCP 2.39 CM	T18REG 281.9 DEG.C
		12 QPEG2 76. WATTS				PDYNDB 1300. KPA	T19REG 185.8 DEG.C
		13 QREG3 24. WATTS				PDLCLR***** KPA	
		14 PFP 949.7 KPA/CM				PDLREG***** KPA	
		15 PFD 206.1 KPA/CM				PDLDIS***** KPA	
		16 NBEALE 0.00457					T03HED***** DEG.C

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 01/19/84 12:55:26.94 RDG 913

FLUID HELIUM		BAROM 14.445 PSI		REGENERATOR 2	DISPLACER 2	STANDARD PISTON	
HEAT TO DASHPOT COOLING	FLODP 4.09 L/MIN	POWER IN		ENGINE CHARGE PRESSURE		GAS TEMPERATURES	SURFACE TEMPERATURES
		AMPS1 658. AMPS		PRESUP 7106. KPA		TGEXP 411.3 DEG.C	T01HTR 451.7 DEG.C
		AMPS2 630. AMPS					T02HTR 455.0 DEG.C
		VOLTG 2.78 VOLTS		MEANBP 6994. KPA		TGREGH 396.4 DEG.C	T03HTR 457.7 DEG.C
				MEANCP 7034. KPA		TGREGC 92.0 DEG.C	T04HTR 445.0 DEG.C
						TGCOMP 56.7 DEG.C	T05HTR 445.5 DEG.C
						TGBOUN 35.0 DEG.C	T06HTR 451.1 DEG.C
HEAT TO COOLER	FLOCRL 4.18 L/MIN	CALCULATED PARAMETERS		VIBRATION		REMOTE CALCULATIONS	T07HTR 417.4 DEG.C
	TWINCL 25.4 DEG.C	1 PWRIN 3583. WATTS		VX1HOR 0.4 CM/S		PWRROUT 663. WATTS	T08HTR 454.4 DEG.C
	TDLCL 8.37 DEG.C	2 QCOOLR 2427. WATTS		VY1VER 8.8 CM/S		INDPWR 662. WATTS	T09HTR 461.7 DEG.C
	TWOCLR 34.05 DEG.C	3 QDSHPT 546. WATTS				PISTST 2.60 CM	T10HTR 450.6 DEG.C
		4 EXTEFF 18.5 %		PHASE ANGLES		DISPST 2.11 CM	T11HTR 447.0 DEG.C
		5 TAVHTR 449.1 DEG.C		PADISP 87.4 DEG.			T12HTR 451.3 DEG.C
		6 INTEFF 21.5 %		PAPRES -9.6 DEG.		DYNAMIC CALCULATIONS	T13REG***** DEG.C
		8 AMPS 1288. AMPS				PAMFC 1206. KPA	T14REG 373.1 DEG.C
		9 QDISPG 2. WATTS		ENGINE SPEED		DISPCP 2.62 CM	T15REG 281.1 DEG.C
		10 QDISP 10. WATTS		FREQ 31.1 HZ		PISTCP 2.39 CM	T16REG***** DEG.C
		11 QREG1 78. WATTS				PDYNDB 1363. KPA	T17REG 276.3 DEG.C
		12 QREG2 75. WATTS				PDLCLR***** KPA	T18REG 280.5 DEG.C
		13 QREG3 24. WATTS				PDLREG***** KPA	T19REG 184.5 DEG.C
		14 PFP 922.8 KPA/CM				PDLDIS***** KPA	T03HED***** DEG.C
		15 PFD 191.0 KPA/CM					
		16 NBEALE 0.00456					

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 01/19/84 13:00:20.94 RDG 914

FLUID HELIUM		BAROM 14.445 PSI		REGENERATOR 2	DISPLACER 2	STANDARD PISTON	
HEAT TO DASHPOT COOLING	FLODP 4.09 L/MIN	POWER IN		ENGINE CHARGE PRESSURE		GAS TEMPERATURES	SURFACE TEMPERATURES
		AMPS1 690. AMPS		PRESUP 7103. KPA		TGEXP 409.9 DEG.C	T01HTR 452.2 DEG.C
		AMPS2 659. AMPS					T02HTR 455.1 DEG.C
		VOLTG 2.92 VOLTS		MEANBP 7012. KPA		TGREGH 395.8 DEG.C	T03HTR 459.6 DEG.C
				MEANCP 7054. KPA		TGREGC 95.1 DEG.C	T04HTR 444.5 DEG.C
						TGCOMP 60.7 DEG.C	T05HTR 446.0 DEG.C
						TGBOUN 35.9 DEG.C	T06HTR 451.0 DEG.C
HEAT TO COOLER	FLOCRL 4.18 L/MIN	CALCULATED PARAMETERS		VIBRATION		REMOTE CALCULATIONS	T07HTR 416.4 DEG.C
	TWINCL 25.5 DEG.C	1 PWRIN 3934. WATTS		VX1HOR 0.4 CM/S		PWRROUT 706. WATTS	T08HTR 454.3 DEG.C
	TDLCL 9.38 DEG.C	2 QCOOLR 2718. WATTS		VY1VER 9.4 CM/S		INDPWR 702. WATTS	T09HTR 462.6 DEG.C
	TWOCLR 35.03 DEG.C	3 QDSHPT 612. WATTS				PISTST 2.80 CM	T10HTR 452.1 DEG.C
		4 EXTEFF 18.0 %		PHASE ANGLES		DISPST 2.22 CM	T11HTR 447.2 DEG.C
		5 TAVHTR 449.3 DEG.C		PADISP 87.5 DEG.			T12HTR 451.3 DEG.C
		6 INTEFF 20.6 %		PAPRES -8.9 DEG.		DYNAMIC CALCULATIONS	T13REG***** DEG.C
		8 AMPS 1349. AMPS				PAMPC 1285. KPA	T14REG 373.5 DEG.C
		9 QDISPG 2. WATTS		ENGINE SPEED		DISPCP 2.69 CM	T15REG 282.5 DEG.C
		10 QDISP 10. WATTS		FREQ 31.1 HZ		PISTCP 2.38 CM	T16REG***** DEG.C
		11 QREG1 76. WATTS				PDYNDB 1488. KPA	T17REG 278.3 DEG.C
		12 QREG2 75. WATTS				PDLCLR***** KPA	T18REG 281.6 DEG.C
		13 QREG3 23. WATTS				PDLREG***** KPA	T19REG 187.5 DEG.C
		14 PFP 914.1 KPA/CM				PDLDIS***** KPA	T03HED***** DEG.C
		15 PFD 179.3 KPA/CM					
		16 NBEALE 0.00451					

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APPENDIX D. - CONTINUED.

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 01/19/84 13:05:21.01 RDG 915

FLUID HELIUM		BAROM 14.445 PSI REGENERATOR 2 DISPLACER 2 STANDARD PISTON			
HEAT TO DASHPOT COOLING		POWER IN	ENGINE CHARGE PRESSURE	GAS TEMPERATURES	SURFACE TEMPERATURES
FLODP 4.06 L/MIN		AMPS1 737. AMPS	PRESUP 7106. KPA	TGEXP 405.7 DEG.C	T01HTR 454.4 DEG.C
		AMPS2 695. AMPS			T02HTR 456.2 DEG.C
TWINDP 17.0 DEG.C	VOLTG 3.11 VOLTS		MEANBP 6998. KPA	TGREGH 394.6 DEG.C	T03HTR 461.7 DEG.C
TDLDP 2.30 DEG.C			MEANCP 7043. KPA	TGREGC 98.1 DEG.C	T04HTR 445.3 DEG.C
TWODPR 19.9 DEG.C				TGCCOMP 64.5 DEG.C	T05HTR 446.3 DEG.C
				TGBOUN 36.9 DEG.C	T06HTR 452.0 DEG.C
					T07HTR 415.5 DEG.C
					T08HTR 455.7 DEG.C
					T09HTR 465.3 DEG.C
HEAT TO COOLER	CALCULATED PARAMETERS	VIBRATION	REMOTE CALCULATIONS		T10HTR 453.1 DEG.C
FLOCLR 4.20 L/MIN	1 PWRRIN 4448. WATTS	VX1HOR 0.5 CM/S	PWRROUT 743. WATTS		T11HTR 448.9 DEG.C
TWINCL 25.5 DEG.C	2 QCOOLR 2998. WATTS	VY1VER10.0 CM/S	INDPWR 732. WATTS		T12HTR 452.0 DEG.C
TDLCL 10.29 DEG.C	3 QDSHPT 651. WATTS		PISTST 2.99 CM		
TWOCLR 35.91 DEG.C	4 EXTEFF 16.7 %		DISPST 2.32 CM		
	5 TAVHTR 450.6 DEG.C	PHASE ANGLES	DYNAMIC CALCULATIONS		
	6 INTEFF 19.9 %	PADISP 87.4 DEG.	PAMPC 1388. KPA	T13REG***** DEG.C	
	8 AMPS 1432. AMPS	PAPRES -8.1 DEG.	DISPCP 2.71 CM	T14REG 370.1 DEG.C	
	9 QDISPG 2. WATTS	ENGINE SPEED	PISTCP 2.35 CM	T15REG 280.8 DEG.C	
	10 QDISP 10. WATTS	FREQ 31.0 HZ	PDYNDB 1538. KPA	T16REG***** DEG.C	
	11 QREG1 74. WATTS		PDLCLR***** KPA	T17REG 278.1 DEG.C	
	12 QREG2 74. WATTS		PDLREG***** KPA	T18REG 279.1 DEG.C	
	13 QREG3 23. WATTS		PDLDIS***** KPA	T19REG 188.4 DEG.C	
	14 PFP 923.9 KPA/CM				T03HED***** DEG.C
	15 PFD 168.2 KPA/CM				
	16 NBEALE 0.00445				

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 01/19/84 13:17:24.01 RDG 916

FLUID HELIUM		BAROM 14.445 PSI REGENERATOR 2 DISPLACER 2 STANDARD PISTON			
HEAT TO DASHPOT COOLING	POWER IN	ENGINE CHARGE PRESSURE	GAS TEMPERATURES	SURFACE TEMPERATURES	
FLODP 4.03 L/MIN	AMPS1 742. AMPS	PRESUP 7110. KPA	TGEXP 406.1 DEG.C	T01HTR 455.6 DEG.C	
	AMPS2 717. AMPS			T02HTR 456.5 DEG.C	
TWINDP 17.1 DEG.C	VOLTG 3.19 VOLTS	MEANBP 7016. KPA	TGREGH 395.8 DEG.C	T03HTR 462.7 DEG.C	
TDLDP 2.60 DEG.C		MEANCP 7059. KPA	TGREGC 102.3 DEG.C	T04HTR 445.1 DEG.C	
TWODPR 20.5 DEG.C			TGCCOMP 69.4 DEG.C	T05HTR 447.9 DEG.C	
			TGBOUN 39.1 DEG.C	T06HTR 451.1 DEG.C	
				T07HTR 415.3 DEG.C	
				T08HTR 456.4 DEG.C	
HEAT TO COOLER	CALCULATED PARAMETERS	VIBRATION	REMOTE CALCULATIONS		T09HTR 466.4 DEG.C
FLOCLR 4.20 L/MIN	1 PWRRIN 4657. WATTS	VX1HOR 0.4 CM/S	PWPOUT 764. WATTS	T10HTR 454.2 DEG.C	
TWINCL 25.6 DEG.C	2 QCOOLR 3372. WATTS	VY1VER10.5 CM/S	INDPWR 754. WATTS	T11HTR 449.9 DEG.C	
TDLCL 11.58 DEG.C	3 QDSHPT 730. WATTS		PISTST 3.19 CM	T12HTR 452.4 DEG.C	
TWOCLR 37.42 DEG.C	4 EXTEFF 16.4 %		DISPST 2.43 CM		
	5 TAVHTR 451.3 DEG.C	PHASE ANGLES	DYNAMIC CALCULATIONS		
	6 INTEFF 18.5 %	PADISP 87.0 DEG.	PAMPC 1585. KPA	T13REG***** DEG.C	
	8 AMPS 1459. AMPS	PAPRES -7.5 DEG.	DISPCP 2.72 CM	T14REG 374.1 DEG.C	
	9 QDISPG 2. WATTS	ENGINE SPEED	PISTCP 2.23 CM	T15REG 284.6 DEG.C	
	10 QDISP 10. WATTS	FREQ 31.0 HZ	PDYNDB 1600. KPA	T16REG***** DEG.C	
	11 QREG1 72. WATTS		PDLCLR***** KPA	T17REG 282.5 DEG.C	
	12 QREG2 75. WATTS		PDLREG***** KPA	T18REG 281.8 DEG.C	
	13 QREG3 23. WATTS		PDLDIS***** KPA	T19REG 193.1 DEG.C	
	14 PFP 990.6 KPA/CM				T03HED***** DEG.C
	15 PFD 171.3 KPA/CM				
	16 NBEALE 0.00428				

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 01/24/84 14:25:18.80 RDG 921

FLUID HELIUM		BAROM 14.268 PSI REGENERATOR 2 DISPLACER 2 STANDARD PISTON			
HEAT TO DASHPOT COOLING	POWER IN	ENGINE CHARGE PRESSURE	GAS TEMPERATURES	SURFACE TEMPERATURES	
FLODP 4.17 L/MIN	AMPS1 519. AMPS	PRESUP 7379. KPA	TGEXP 466.3 DEG.C	T01HTR 501.8 DEG.C	
	AMPS2 549. AMPS			T02HTR 506.5 DEG.C	
TWINDP 17.0 DEG.C	VOLTG 2.35 VOLTS	MEANBP 7012. KPA	TGREGH 449.3 DEG.C	T03HTR 508.2 DEG.C	
TDLDP 1.33 DEG.C		MEANCP 7027. KPA	TGREGC 85.6 DEG.C	T04HTR 493.0 DEG.C	
TWODPR 18.9 DEG.C			TGCCOMP 43.1 DEG.C	T05HTR 496.5 DEG.C	
			TGBOUN 30.7 DEG.C	T06HTR 504.1 DEG.C	
				T07HTR 471.9 DEG.C	
				T08HTR 506.7 DEG.C	
HEAT TO COOLER	CALCULATED PARAMETERS	VIBRATION	REMOTE CALCULATIONS		T09HTR 509.8 DEG.C
FLOCLR 4.23 L/MIN	1 PWRRIN 2513. WATTS	VX1HOR 0.3 CM/S	PWRROUT 531. WATTS	T10HTR 501.2 DEG.C	
TWINCL 25.0 DEG.C	2 QCOOLR 1598. WATTS	VY1VER 6.5 CM/S	INDPWR 567. WATTS	T11HTR 497.9 DEG.C	
TDLCL 5.45 DEG.C	3 QDSHPT 385. WATTS		PISTST 1.80 CM	T12HTR 504.1 DEG.C	
TWOCLR 30.63 DEG.C	4 EXTEFF 21.1 %		DISPST 1.69 CM		
	5 TAVHTR 500.6 DEG.C	PHASE ANGLES	DYNAMIC CALCULATIONS		
	6 INTEFF 25.0 %	PADISP 85.9 DEG.	PAMPC 935. KPA	T13REG***** DEG.C	
	8 AMPS 1069. AMPS	PAPRES -15.1 DEG.	DISPCP 2.59 CM	T14REG 420.1 DEG.C	
	9 QDISPG 2. WATTS	ENGINE SPEED	PISTCP 2.34 CM	T15REG 310.7 DEG.C	
	10 QDISP 12. WATTS	FREQ 31.9 HZ	PDYNDB 1075. KPA	T16REG***** DEG.C	
	11 QREG1 95. WATTS		PDLCLR***** KPA	T17REG 304.2 DEG.C	
	12 QREG2 89. WATTS		PDLREG***** KPA	T18REG 310.4 DEG.C	
	13 QREG3 28. WATTS		PDLDIS***** KPA	T19REG 193.8 DEG.C	
	14 PFP 1025.4 KPA/CM				T03HED***** DEG.C
	15 PFD 288.3 KPA/CM				
	16 NBEALE 0.00515				

APPENDIX D. - CONTINUED.

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 01/24/84 14:30:18.80 RDG 922

FLUID HELIUM BAROM 14.268 PSI REGENERATOR 2 DISPLACER 2 STANDARD PISTON

HEAT TO DASHPOT COOLING		POWER IN	ENGINE CHARGE PRESSURE	GAS TEMPERATURES	SURFACE TEMPERATURES
FLODP	4.19 L/MIN	AMPS1 557. AMPS AMPS2 574. AMPS	PRESUP 7173. KPA	TGEXP 460.7 DEG.C	T01HTR 500.9 DEG.C T02HTR 507.4 DEG.C
TWINDP	16.8 DEG.C	VOLTG 2.50 VOLTS	MEANBP 7012. KPA	TGREGH 446.4 DEG.C	T03HTR 508.3 DEG.C
TDLDP	1.45 DEG.C		MEANCP 7028. KPA	TGREGC 88.0 DEG.C	T04HTR 498.0 DEG.C
TWODPR	18.9 DEG.C			TGCOMP 45.7 DEG.C	T05HTR 496.7 DEG.C
				TGBOUN 31.4 DEG.C	T06HTR 502.2 DEG.C
					T07HTR 471.6 DEG.C
					T08HTR 505.8 DEG.C
					T09HTR 511.2 DEG.C
					T10HTR 500.4 DEG.C
					T11HTR 497.4 DEG.C
					T12HTR 503.9 DEG.C

HEAT TO COOLER		CALCULATED PARAMETERS	VIBRATION	REMOTE CALCULATIONS	SURFACE TEMPERATURES
FLOCLR	4.25 L/MIN	1 PWRIN 2826. WATTS	VX1HOR 0.3 CM/S	PWRROUT 599. WATTS	T13REG***** DEG.C
TWINCL	25.0 DEG.C	2 QCOOLR 1832. WATTS	VY1VER 7.1 CM/S	INDPWR 642. WATTS	T14REG 419.2 DEG.C
TDLCL	6.22 DEG.C	3 QDSHPT 424. WATTS		PISTST 1.99 CM	T15REG 311.2 DEG.C
TWOCLR	31.31 DEG.C	4 EXTEFF 21.2 %		DISPST 1.81 CM	T16REG***** DEG.C
		5 TAVHTR 500.3 DEG.C	PHASE ANGLES		T17REG 303.3 DEG.C
		6 INTEFF 24.6 %	PADISP 86.3 DEG.	DYNAMIC CALCULATIONS	T18REG 309.8 DEG.C
		8 AMPS 1130. AMPS	PAPRES -14.1 DEG.	PAMPC 1038. KPA	T19REG 197.1 DEG.C
		9 QDISPG 2. WATTS		DISPCP 2.62 CM	T03HED***** DEG.C
		10 QDISP 12. WATTS	ENGINE SPEED	PISTCP 2.35 CM	
		11 QREG1 91. WATTS	FREQ 31.8 HZ	PDYMDB 1175. KPA	
		12 QREG2 89. WATTS		PDLCLR***** KPA	
		13 QREG3 28. WATTS		PDLREG***** KPA	
		14 PFP 1026.1 KPA/CM		PDLDIS***** KPA	
		15 PFD 280.3 KPA/CM			
		16 NBEALE 0.00525			

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 01/24/84 14:35:30.80 RDG 923

FLUID HELIUM BAROM 14.263 PSI REGENERATOR 2 DISPLACER 2 STANDARD PISTON

HEAT TO DASHPOT COOLING FLODP	4.18 L/MIN	POWER IN AMPS1 602. AMPS AMPS2 603. AMPS	ENGINE CHARGE PRESSURE PRESUP 7149. KPA	GAS TEMPERATURES TGEXP 459.8 DEG.C	SURFACE TEMPERATURES T01HTR 501.9 DEG.C T02HTR 507.2 DEG.C
TWINDP	16.7 DEG.C	VOLTG 2.65 VOLTS	MEANBP 6989. KPA	TGREGH 444.4 DEG.C	T03HTR 509.9 DEG.C
TDLDP	1.69 DEG.C		MEANCP 7008. KPA	TGREGC 90.2 DEG.C	T04HTR 496.9 DEG.C
TWODPR	19.0 DEG.C			TGCOMP 49.2 DEG.C	T05HTR 495.7 DEG.C
				TGBOUN 32.3 DEG.C	T06HTR 502.2 DEG.C

HEAT TO COOLER	CALCULATED PARAMETERS	VIBRATION	REMOTE CALCULATIONS	T09HTR
FLOCLR 4.24 L/MIN	1 PWRIN 3188. WATTS	VXIHOR 0.4 CM/S	PWRROUT 667. WATTS	T10HTR 501.2 DEG.C
TWINCL 25.0 DEG.C	2 QCOOLR 2073. WATTS	VY1VER 7.8 CM/S	INDPWR 712. WATTS	T11HTR 497.1 DEG.C
TDLCL 7.04 DEG.C	3 QDSHPT 492. WATTS		PISTST 2.20 CM	T12HTR 503.4 DEG.C
TWCCLR 32.19 DEG.C	4 EXTEFF 20.9 %	PHASE ANGLES	DISPST 1.92 CM	
	5 TAVHTR 500.2 DEG.C	PADISP 86.8 DEG.		T13REG***** DEG.C
	6 INTEFF 24.3 %	PAPRES -12.9 DEG.	DYNAMIC CALCULATIONS	T14REG 418.0 DEG.C
	8 AMPS 1205. AMPS		PAMPC 1137. KPA	T15REG 312.1 DEG.C
	9 QDISPG 2. WATTS	ENGINE SPEED	DISPCP 2.61 CM	T16REG***** DEG.C
10 QDISP 12. WATTS		FREQ 31.7 HZ	PISTCP 2.35 CM	T17REG 302.8 DEG.C
11 QREG1 91. WATTS			PDYNDB 1238. KPA	T18REG 312.0 DEG.C
12 QREG2 86. WATTS			PDLCLR***** KPA	T19REG 199.8 DEG.C
13 QREG3 27. WATTS			PDLREG***** KPA	
14 PFP 1019.9 KPA/CM			PDLDIS***** KPA	T03SHED***** DEG.C
15 PFD 264.1 KPA/CM				
16 NBEALE 0.00533				

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 01/24/84 14:40:18.80 RDG 924

FLUID HELIUM BAROM 14.263 PSI REGENERATOR 2 DISPLACER 2 STANDARD PISTON

HEAT TO DASHPOT COOLING FLODP	4.18 L/MIN	POWER IN AMPS1 AMPS2	641. AMPS 628. AMPS	ENGINE CHARGE PRESSURE PRESUP	7385. KPA	GAS TEMPERATURES TGEXP	458.2 DEG.C	SURFACE TEMPERATURES T01HTR	501.5 DEG.C
TWINDP	16.6 DEG.C	VOLTG	2.79 VOLTS	MEANBP	7004. KPA	TGREGH	442.1 DEG.C	T03HTR	509.9 DEG.C
TDLDP	1.95 DEG.C			MEANCP	7023. KPA	TGREGC	93.2 DEG.C	T04HTR	496.1 DEG.C
TWODPR	19.2 DEG.C					TGCOMP	52.8 DEG.C	T05HTR	495.7 DEG.C
						TGBOUN	33.4 DEG.C	T06HTR	500.8 DEG.C

HEAT TO COOLER	CALCULATED PARAMETERS	VIBRATION	REMOTE CALCULATIONS	T09HTR
FLOCLR 4.25 L/MIN	1 PWRIN 3536. WATTS	VX1HOR 0.4 CM/S	PWRROUT 725. WATTS	T10HTR 500.7 DEG.C
TWINCLR 25.1 DEG.C	2 QCOOLR 2313. WATTS	VY1VER 8.4 CM/S	INDPWR 714. WATTS	T11HTR 496.6 DEG.C
TDLCL 7.85 DEG.C	3 QDSHPT 566. WATTS		PISTST 2.40 CM	T12HTR 502.6 DEG.C
TWOCLR 33.12 DEG.C	4 EXTEFF 20.5 %	PHASE ANGLES	DISPST 2.03 CM	
	5 TAVHTR 499.7 DEG.C	PADISP 87.0 DEG.		T13REG***** DEG.C
	6 INTEFF 23.9 %	PAPRES -11.8 DEG.	DYNAMIC CALCULATIONS	T14REG 417.8 DEG.C
	8 AMPS 1269. AMPS		PAMPC 1240. KPA	T15REG 313.1 DEG.C
	9 QDISPG 2. WATTS	ENGINE SPEED	DISPCP 2.61 CM	T16REG***** DEG.C
	10 QDISP 12. WATTS	FREQ 31.6 HZ	PISTCP 2.38 CM	T17REG 302.5 DEG.C
	11 QREG1 88. WATTS		PDYNDB 1325. KPA	T18REG 311.4 DEG.C
	12 QREG2 86. WATTS		PDLCLR***** KPA	T19REG 202.6 DEG.C
	13 QREG3 27. WATTS		PDLREG***** KPA	
	14 PFP 1022.3 KPA/CM		PDLDIS***** KPA	T03HED***** DEG.C
	15 PFD 251.0 KPA/CM			
	16 NBEALE 0.00531	78	ORIGINAL PAGE IS	

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APPENDIX D. - CONTINUED.

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 01/24/84 14:45:18.80 RDG 925

FLUID HELIUM		BAROM 14.263 PSI		REGENERATOR 2 DISPLACER 2 STANDARD PISTON		GAS TEMPERATURES		SURFACE TEMPERATURES	
HEAT TO DASHPOT COOLING	FLODP 4.17 L/MIN	POWER IN		ENGINE CHARGE PRESSURE		TGEXP 456.9 DEG.C		T01HTR 502.9 DEG.C	
		AMPS1 680. AMPS		PRESUP 7177. KPA		T02HTR 505.9 DEG.C		T02HTR 505.9 DEG.C	
		AMPS2 653. AMPS		MEANBP 7005. KPA		TGREGH 442.7 DEG.C		T03HTR 510.5 DEG.C	
		VOLTG 2.92 VOLTS		MEANCP 7024. KPA		TGREGC 96.4 DEG.C		T04HTR 495.3 DEG.C	
						TGCOMP 57.0 DEG.C		T05HTR 495.7 DEG.C	
						TGBOUN 34.6 DEG.C		T06HTR 501.7 DEG.C	
								T07HTR 467.0 DEG.C	
								T08HTR 505.0 DEG.C	
								T09HTR 513.5 DEG.C	
								T10HTR 501.9 DEG.C	
								T11HTR 497.7 DEG.C	
								T12HTR 501.4 DEG.C	
HEAT TO COOLER	FLOCRL 4.25 L/MIN	CALCULATED PARAMETERS		VIBRATION		REMOTE CALCULATIONS		T13REG***** DEG.C	
		1 PWRIN 3888. WATTS		VX1HOR 0.4 CM/S		PWRROUT 794. WATTS		T14REG 416.5 DEG.C	
		2 QCOOLR 2566. WATTS		VY1VER 9.0 CM/S		INDPWR 841. WATTS		T15REG 311.5 DEG.C	
		3 QDSHPT 644. WATTS				PISTST 2.60 CM		T16REG***** DEG.C	
		4 EXTEFF 20.4 %		PHASE ANGLES		DISPST 2.15 CM		T17REG 305.9 DEG.C	
		5 TAVHTR 499.9 DEG.C		PADISP 85.4 DEG.		DYNAMIC CALCULATIONS		T18REG 311.5 DEG.C	
		6 INTEFF 23.6 %		PAPRES -11.4 DEG.		PAMPC 1319. KPA		T19REG 201.5 DEG.C	
		8 AMPS 1333. AMPS				DISPCP 2.71 CM			
		9 QDISPG 2. WATTS		ENGINE SPEED		PISTCP 2.35 CM			
		10 QDISP 11. WATTS		FREQ 31.4 HZ		PDIYNDB 1450. KPA			
		11 QREG1 89. WATTS				PDLCLR***** KPA			
		12 QREG2 85. WATTS				PDLREG***** KPA			
		13 QREG3 27. WATTS				PDLDIS***** KPA			
		14 PFP 1012.7 KPA/CM						T03HED***** DEG.C	
		15 PFD 242.5 KPA/CM							
		16 NBEALE 0.00542							

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 01/24/84 14:50:21.80 RDG 926

FLUID HELIUM		BAROM 14.263 PSI		REGENERATOR 2 DISPLACER 2 STANDARD PISTON		GAS TEMPERATURES		SURFACE TEMPERATURES	
HEAT TO DASHPOT COOLING	FLODP 4.15 L/MIN	POWER IN		ENGINE CHARGE PRESSURE		TGEXP 455.9 DEG.C		T01HTR 504.7 DEG.C	
		AMPS1 715. AMPS		PRESUP 7167. KPA		T02HTR 506.3 DEG.C		T02HTR 506.3 DEG.C	
		AMPS2 684. AMPS		MEANBP 6996. KPA		TGREGH 442.1 DEG.C		T03HTR 512.2 DEG.C	
		VOLTG 3.07 VOLTS		MEANCP 7021. KPA		TGREGC 99.9 DEG.C		T04HTR 495.1 DEG.C	
						TGCOMP 61.3 DEG.C		T05HTR 496.8 DEG.C	
						TGBOUN 36.1 DEG.C		T06HTR 502.3 DEG.C	
								T07HTR 466.1 DEG.C	
								T08HTR 505.6 DEG.C	
								T09HTR 515.0 DEG.C	
								T10HTR 503.6 DEG.C	
								T11HTR 498.8 DEG.C	
								T12HTR 501.8 DEG.C	
HEAT TO COOLER	FLOCRL 4.25 L/MIN	CALCULATED PARAMETERS		VIBRATION		REMOTE CALCULATIONS		T13REG***** DEG.C	
		1 PWRIN 4293. WATTS		VX1HOR 0.4 CM/S		PWRROUT 853. WATTS		T14REG 415.8 DEG.C	
		2 QCOOLR 2895. WATTS		VY1VER 9.7 CM/S		INDPWR 901. WATTS		T15REG 311.0 DEG.C	
		3 QDSHPT 730. WATTS				PISTST 2.80 CM		T16REG***** DEG.C	
		4 EXTEFF 19.9 %		PHASE ANGLES		DISPST 2.27 CM		T17REG 305.9 DEG.C	
		5 TAVHTR 500.7 DEG.C		PADISP 85.4 DEG.		DYNAMIC CALCULATIONS		T18REG 310.3 DEG.C	
		6 INTEFF 22.8 %		PAPRES -10.6 DEG.		PAMPC 1383. KPA		T19REG 202.5 DEG.C	
		8 AMPS 1398. AMPS				DISPCP 2.71 CM			
		9 QDISPG 2. WATTS		ENGINE SPEED		PISTCP 2.31 CM			
		10 QDISP 11. WATTS		FREQ 31.3 HZ		PDIYNDB 1525. KPA			
		11 QREG1 87. WATTS				PDLCLR***** KPA			
		12 QREG2 86. WATTS				PDLREG***** KPA			
		13 QREG3 26. WATTS				PDLDIS***** KPA			
		14 PFP 985.0 KPA/CM						T03HED***** DEG.C	
		15 PFD 224.7 KPA/CM							
		16 NBEALE 0.00541							

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 01/24/84 14:55:18.80 RDG 927

FLUID HELIUM		BAROM 14.263 PSI		REGENERATOR 2 DISPLACER 2 STANDARD PISTON		GAS TEMPERATURES		SURFACE TEMPERATURES	
HEAT TO DASHPOT COOLING	FLODP 4.14 L/MIN	POWER IN		ENGINE CHARGE PRESSURE		TGEXP 455.3 DEG.C		T01HTR 504.7 DEG.C	
		AMPS1 747. AMPS		PRESUP 7398. KPA		T02HTR 505.4 DEG.C		T02HTR 505.4 DEG.C	
		AMPS2 710. AMPS		MEANBP 7009. KPA		TGREGH 440.8 DEG.C		T03HTR 512.5 DEG.C	
		VOLTG 3.20 VOLTS		MEANCP 7037. KPA		TGREGC 103.2 DEG.C		T04HTR 494.0 DEG.C	
						TGCOMP 65.1 DEG.C		T05HTR 496.1 DEG.C	
						TGBOUN 37.6 DEG.C		T06HTR 501.8 DEG.C	
								T07HTR 464.1 DEG.C	
								T08HTR 505.1 DEG.C	
								T09HTR 515.2 DEG.C	
								T10HTR 503.9 DEG.C	
								T11HTR 498.7 DEG.C	
								T12HTR 500.9 DEG.C	
HEAT TO COOLER	FLOCRL 4.27 L/MIN	CALCULATED PARAMETERS		VIBRATION		REMOTE CALCULATIONS		T13REG***** DEG.C	
		1 PWRIN 4664. WATTS		VX1HOR 0.4 CM/S		PWRROUT 897. WATTS		T14REG 414.4 DEG.C	
		2 QCOOLR 3188. WATTS		VY1VER 10.3 CM/S		INDPWR 945. WATTS		T15REG 310.7 DEG.C	
		3 QDSHPT 798. WATTS				PISTST 2.99 CM		T16REG***** DEG.C	
		4 EXTEFF 19.2 %		PHASE ANGLES		DISPST 2.36 CM		T17REG 308.2 DEG.C	
		5 TAVHTR 500.2 DEG.C		PADISP 85.2 DEG.		DYNAMIC CALCULATIONS		T18REG 309.9 DEG.C	
		6 INTEFF 22.0 %		PAPRES -9.8 DEG.		PAMPC 1516. KPA		T19REG 204.6 DEG.C	
		8 AMPS 1457. AMPS				DISPCP 2.72 CM			
		9 QDISPG 2. WATTS		ENGINE SPEED		PISTCP 2.25 CM			
		10 QDISP 11. WATTS		FREQ 31.3 HZ		PDIYNDB 1588. KPA			
		11 QREG1 85. WATTS				PDLCLR***** KPA			
		12 QREG2 85. WATTS				PDLREG***** KPA			
		13 QREG3 26. WATTS				PDLDIS***** KPA			
		14 PFP 1014.4 KPA/CM						T03HED***** DEG.C	
		15 PFD 218.5 KPA/CM							
		16 NBEALE 0.00533							

APPENDIX D. - CONTINUED.

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 01/24/84 15:00:18.80 RDG 928

FLUID HELIUM BAROM 14.263 PSI REGENERATOR 2 DISPLACER 2 STANDARD PISTON

HEAT TO DASHPOT COOLING FLODP 4.14 L/MIN	POWER IN AMPS1 775. AMPS AMPS2 738. AMPS VOLTG 3.34 VOLTS	ENGINE CHARGE PRESSURE PRESUP 7387. KPA MEANBP 7007. KPA MEANCP 7044. KPA	GAS TEMPERATURES TGEXP 454.0 DEG.C TGREGH 439.9 DEG.C TGREGC 107.4 DEG.C TGCOMP 70.1 DEG.C TGBOUN 39.0 DEG.C	SURFACE TEMPERATURES T01HTR 505.2 DEG.C T02HTR 504.5 DEG.C T03HTR 513.0 DEG.C T04HTR 493.0 DEG.C T05HTR 495.4 DEG.C T06HTR 501.6 DEG.C T07HTR 462.0 DEG.C T08HTR 505.0 DEG.C T09HTR 515.9 DEG.C T10HTR 504.0 DEG.C T11HTR 499.0 DEG.C T12HTR 500.0 DEG.C
HEAT TO COOLER FLOCLR 4.28 L/MIN TWINCL 25.3 DEG.C TDLCL 11.95 DEG.C TWOCLR 37.41 DEG.C	CALCULATED PARAMETERS 1 PWRIN 5062. WATTS 2 QCOOLR 3545. WATTS 3 QDSHPT 869. WATTS 4 EXTEFF 18.9 % 5 TAVHTR 499.9 DEG.C 6 INTEFF 21.2 % 8 AMPS 1514. AMPS 9 QDISPG 2. WATTS 10 QDISP 11. WATTS 11 QREG1 83. WATTS 12 QREG2 83. WATTS 13 QREG3 26. WATTS 14 PFP 1018.2 KPA/CM 15 PFD 207.8 KPA/CM 16 NBEALE 0.00533	VIBRATION VX1HOR 0.4 CM/S VY1VER10.9 CM/S PHASE ANGLES PADISP 84.9 DEG. PAPRES -9.1 DEG. ENGINE SPEED FREQ 31.2 HZ	REMOTE CALCULATIONS PWRROUT 956. WATTS INDPWR 985. WATTS PISTST 3.20 CM DISPST 2.47 CM DYNAMIC CALCULATIONS PAMPC 1624. KPA DISPCP 2.74 CM PISTCP 2.19 CM PDYNDB 1638. KPA PDLCLR***** KPA PDLREG***** KPA PDLDIS***** KPA	T13REG***** DEG.C T14REG 412.3 DEG.C T15REG 309.5 DEG.C T16REG***** DEG.C T17REG 310.4 DEG.C T18REG 309.5 DEG.C T19REG 206.6 DEG.C T03HED***** DEG.C

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 01/24/84 15:02:57.83 RDG 929

FLUID HELIUM BAROM 14.268 PSI REGENERATOR 2 DISPLACER 2 STANDARD PISTON

HEAT TO DASHPOT COOLING FLODP 4.14 L/MIN	POWER IN AMPS1 811. AMPS AMPS2 767. AMPS VOLTG 3.49 VOLTS	ENGINE CHARGE PRESSURE PRESUP 7383. KPA MEANBP 7005. KPA MEANCP 7040. KPA	GAS TEMPERATURES TGEXP 452.2 DEG.C TGREGH 437.7 DEG.C TGREGC 111.0 DEG.C TGCOMP 74.4 DEG.C TGBOUN 39.8 DEG.C	SURFACE TEMPERATURES T01HTR 504.4 DEG.C T02HTR 503.5 DEG.C T03HTR 512.8 DEG.C T04HTR 491.5 DEG.C T05HTR 495.2 DEG.C T06HTR 500.3 DEG.C T07HTR 459.6 DEG.C T08HTR 504.0 DEG.C T09HTR 515.9 DEG.C
HEAT TO COOLER FLOCLR 4.28 L/MIN TWINCL 25.3 DEG.C TDLCL 12.99 DEG.C TWOCLR 38.37 DEG.C	CALCULATED PARAMETERS 1 PWRIN 5505. WATTS 2 QCOOLR 3855. WATTS 3 QDSHPT 903. WATTS 4 EXTEFF 17.3 % 5 TAVHTR 499.0 DEG.C 6 INTEFF 19.8 % 8 AMPS 1578. AMPS 9 QDISPG 2. WATTS 10 QDISP 11. WATTS 11 QREG1 82. WATTS 12 QREG2 81. WATTS 13 QREG3 25. WATTS 14 PFP 1023.6 KPA/CM 15 PFD 189.9 KPA/CM 16 NBEALE 0.00501	VIBRATION VX1HOR 0.4 CM/S VY1VER11.5 CM/S PHASE ANGLES PADISP 84.7 DEG. PAPRES -8.2 DEG. ENGINE SPEED FREQ 31.2 HZ	REMOTE CALCULATIONS PWRROUT 955. WATTS INDPWR 998. WATTS PISTST 3.39 CM DISPST 2.61 CM DYNAMIC CALCULATIONS PAMPC 1732. KPA DISPCP 2.75 CM PISTCP 2.07 CM PDYNDB 1813. KPA PDLCLR***** KPA PDLREG***** KPA PDLDIS***** KPA	T10HTR 503.5 DEG.C T11HTR 498.1 DEG.C T12HTR 499.0 DEG.C T13REG***** DEG.C T14REG 410.6 DEG.C T15REG 310.2 DEG.C T16REG***** DEG.C T17REG 311.1 DEG.C T18REG 310.3 DEG.C T19REG 209.5 DEG.C T03HED***** DEG.C

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 01/24/84 15:13:21.83 RDG 930

FLUID HELIUM BAROM 14.268 PSI REGENERATOR 2 DISPLACER 2 STANDARD PISTON

HEAT TO DASHPOT COOLING FLODP 4.16 L/MIN	POWER IN AMPS1 543. AMPS AMPS2 549. AMPS VOLTG 2.42 VOLTS	ENGINE CHARGE PRESSURE PRESUP 7173. KPA MEANBP 7011. KPA MEANCP 7026. KPA	GAS TEMPERATURES TGEXP 654.3 DEG.C TGREGH 495.7 DEG.C TGREGC 89.6 DEG.C TGCOMP 45.3 DEG.C TGBOUN 37.5 DEG.C	SURFACE TEMPERATURES T01HTR 551.4 DEG.C T02HTR 555.6 DEG.C T03HTR 558.4 DEG.C T04HTR 546.3 DEG.C T05HTR 545.8 DEG.C T06HTR 553.3 DEG.C T07HTR 520.2 DEG.C T08HTR 556.0 DEG.C T09HTR 558.5 DEG.C
HEAT TO COOLER FLOCLR 4.26 L/MIN TWINCL 24.9 DEG.C TDLCL 5.89 DEG.C TWOCLR 31.05 DEG.C	CALCULATED PARAMETERS 1 PWRIN 2637. WATTS 2 QCOOLR 1742. WATTS 3 QDSHPT 566. WATTS 4 EXTEFF 22.4 % 5 TAVHTR 549.7 DEG.C 6 INTEFF 25.3 % 8 AMPS 1092. AMPS 9 QDISPG 3. WATTS 10 QDISP 17. WATTS 11 QREG1 105. WATTS 12 QREG2 100. WATTS 13 QREG3 31. WATTS 14 PFP 1171.7 KPA/CM 15 PFD 357.9 KPA/CM 16 NBEALE 0.00571	VIBRATION VX1HOR 0.3 CM/S VY1VER 6.5 CM/S PHASE ANGLES PADISP 83.9 DEG. PAPRES -16.7 DEG. ENGINE SPEED FREQ 32.2 HZ	REMOTE CALCULATIONS PWRROUT 590. WATTS INDPWR 630. WATTS PISTST 1.79 CM DISPST 1.70 CM DYNAMIC CALCULATIONS PAMPC 1058. KPA DISPCP 2.68 CM PISTCP 2.40 CM PDYNDB 1075. KPA PDLCLR***** KPA PDLREG***** KPA PDLDIS***** KPA	T10HTR 550.9 DEG.C T11HTR 547.3 DEG.C T12HTR 553.1 DEG.C T13REG***** DEG.C T14REG 462.4 DEG.C T15REG 340.6 DEG.C T16REG***** DEG.C T17REG 332.7 DEG.C T18REG 339.2 DEG.C T19REG 210.2 DEG.C T03HED***** DEG.C

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APPENDIX D. - CONTINUED.

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 01/24/84 15:18:18.83 RDG 931

FLUID HELIUM		BAROM 14.263 PSI		REGENERATOR 2	DISPLACER 2	STANDARD PISTON	SURFACE TEMPERATURES
HEAT TO DASHPOT COOLING	FLODP 4.17 L/MIN	POWER IN		ENGINE CHARGE PRESSURE		GAS TEMPERATURES	
		AMPS1 588. AMPS		PRESUP 7404. KPA		TGEXP 695.6 DEG.C	T01HTR 551.1 DEG.C
		AMPS2 587. AMPS	VOLTG 2.60 VOLTS	MEANBP 7005. KPA		TGREGH 492.7 DEG.C	T02HTR 557.4 DEG.C
				MEANCP 7032. KPA		TGREGC 92.4 DEG.C	T03HTR 559.3 DEG.C
						TGCOMP 47.9 DEG.C	T04HTR 546.8 DEG.C
						TGBOUN 37.2 DEG.C	T05HTR 547.3 DEG.C
							T06HTR 551.9 DEG.C
							T07HTR 521.0 DEG.C
							T08HTR 555.5 DEG.C
							T09HTR 561.3 DEG.C
HEAT TO COOLER	FLOCRL 4.24 L/MIN	CALCULATED PARAMETERS		VIBRATION		REMOTE CALCULATIONS	
		1 PWRIN 3053. WATTS		VX1HOR 0.3 CM/S		PWRROUT 690. WATTS	T10HTR 550.7 DEG.C
		2 QCOOLR 1981. WATTS		VY1VER 7.2 CM/S		INDPWR 734. WATTS	T11HTR 547.2 DEG.C
		3 QDSHPT 612. WATTS				PISTST 2.01 CM	T12HTR 553.6 DEG.C
		4 EXTEFF 22.6 %		PHASE ANGLES		DISPST 1.86 CM	
		5 TAVHTR 550.3 DEG.C		PADISP 84.5 DEG.			T13REG***** DEG.C
		6 INTEFF 25.8 %		PAPRES -15.7 DEG.			T14REG 463.5 DEG.C
		8 AMPS 1174. AMPS		ENGINE SPEED			T15REG 344.0 DEG.C
		9 QDISPG 4. WATTS		FREQ 32.0 HZ			T16REG***** DEG.C
		10 QDISP 18. WATTS					T17REG 331.1 DEG.C
		11 QREG1 100. WATTS					T18REG 339.3 DEG.C
		12 QREG2 101. WATTS					T19REG 215.5 DEG.C
		13 QREG3 31. WATTS					
		14 PFP 1028.5 KPA/CM					T03HED***** DEG.C
		15 PFD 305.5 KPA/CM					
		16 NBEALE 0.00597					

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 01/24/84 15:23:18.86 RDG 932

FLUID HELIUM		BAROM 14.263 PSI		REGENERATOR 2	DISPLACER 2	STANDARD PISTON	SURFACE TEMPERATURES
HEAT TO DASHPOT COOLING	FLODP 4.18 L/MIN	POWER IN		ENGINE CHARGE PRESSURE		GAS TEMPERATURES	
		AMPS1 623. AMPS		PRESUP 7308. KPA		TGEXP 713.1 DEG.C	T01HTR 551.6 DEG.C
		AMPS2 613. AMPS	VOLTG 2.74 VOLTS	MEANBP 7019. KPA		TGREGH 490.5 DEG.C	T02HTR 556.6 DEG.C
				MEANCP 7059. KPA		TGREGC 95.4 DEG.C	T03HTR 559.8 DEG.C
						TGCOMP 51.2 DEG.C	T04HTR 545.7 DEG.C
						TGBOUN 37.7 DEG.C	T05HTR 546.2 DEG.C
HEAT TO COOLER	FLOCRL 4.23 L/MIN	CALCULATED PARAMETERS		VIBRATION		REMOTE CALCULATIONS	
		1 PWRIN 3388. WATTS		VX1HOR 0.4 CM/S		PWRROUT 764. WATTS	T10HTR 550.6 DEG.C
		2 QCOOLR 2200. WATTS		VY1VER 7.8 CM/S		INDPWR 813. WATTS	T11HTR 546.7 DEG.C
		3 QDSHPT 663. WATTS				PISTST 2.20 CM	T12HTR 552.3 DEG.C
		4 EXTEFF 22.5 %		PHASE ANGLES		DISPST 1.97 CM	
		5 TAVHTR 549.7 DEG.C		PADISP 84.5 DEG.			T13REG***** DEG.C
		6 INTEFF 25.8 %		PAPRES -14.8 DEG.			T14REG 461.0 DEG.C
		8 AMPS 1236. AMPS		ENGINE SPEED			T15REG 342.3 DEG.C
		9 QDISPG 4. WATTS		FREQ 31.9 HZ			T16REG***** DEG.C
		10 QDISP 19. WATTS					T17REG 331.0 DEG.C
		11 QREG1 101. WATTS					T18REG 340.8 DEG.C
		12 QREG2 98. WATTS					T19REG 216.0 DEG.C
		13 QREG3 31. WATTS					
		14 PFP 1030.8 KPA/CM					T03HED***** DEG.C
		15 PFD 297.0 KPA/CM					
		16 NBEALE 0.00604					

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 01/24/84 15:28:21.86 RDG 933

FLUID HELIUM		BAROM 14.263 PSI		REGENERATOR 2	DISPLACER 2	STANDARD PISTON	SURFACE TEMPERATURES
HEAT TO DASHPOT COOLING	FLODP 4.19 L/MIN	POWER IN		ENGINE CHARGE PRESSURE		GAS TEMPERATURES	
		AMPS1 654. AMPS		PRESUP 7129. KPA		TGEXP 722.9 DEG.C	T01HTR 551.2 DEG.C
		AMPS2 639. AMPS	VOLTG 2.87 VOLTS	MEANBP 6996. KPA		TGREGH 487.8 DEG.C	T02HTR 556.2 DEG.C
				MEANCP 7028. KPA		TGREGC 97.4 DEG.C	T03HTR 560.1 DEG.C
						TGCOMP 54.1 DEG.C	T04HTR 544.6 DEG.C
						TGBOUN 38.2 DEG.C	T05HTR 546.6 DEG.C
HEAT TO COOLER	FLOCRL 4.23 L/MIN	CALCULATED PARAMETERS		VIBRATION		REMOTE CALCULATIONS	
		1 PWRIN 3706. WATTS		VX1HOR 0.4 CM/S		PWRROUT 831. WATTS	T10HTR 550.3 DEG.C
		2 QCOOLR 2440. WATTS		VY1VER 8.4 CM/S		INDPWR 883. WATTS	T11HTR 545.7 DEG.C
		3 QDSHPT 737. WATTS				PISTST 2.39 CM	T12HTR 551.9 DEG.C
		4 EXTEFF 22.4 %		PHASE ANGLES		DISPST 2.06 CM	
		5 TAVHTR 549.1 DEG.C		PADISP 85.3 DEG.			T13REG***** DEG.C
		6 INTEFF 25.4 %		PAPRES -13.5 DEG.			T14REG 460.6 DEG.C
		8 AMPS 1293. AMPS		ENGINE SPEED			T15REG 343.1 DEG.C
		9 QDISPG 4. WATTS		FREQ 31.8 HZ			T16REG***** DEG.C
		10 QDISP 19. WATTS					T17REG 329.5 DEG.C
		11 QREG1 98. WATTS					T18REG 339.7 DEG.C
		12 QREG2 98. WATTS					T19REG 218.5 DEG.C
		13 QREG3 30. WATTS					
		14 PFP 1027.4 KPA/CM					T03HED***** DEG.C
		15 PFD 280.9 KPA/CM					
		16 NBEALE 0.00607					

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APPENDIX D. - CONTINUED.

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 01/24/84 15:33:18.88 RDG 934

FLUID HELIUM		BAROM 14.263 PSI REGENERATOR 2 DISPLACER 2 STANDARD PISTON				SURFACE TEMPERATURES	
HEAT TO DASHPOT COOLING	FLODP 4.20 L/MIN	POWER IN	AMPS1 692. AMPS	ENGINE CHARGE PRESSURE	TGEXP 733.3 DEG.C	T01HTR 553.2 DEG.C	
			AMPS2 669. AMPS	PRESUP 7454. KPA		T02HTR 555.6 DEG.C	
TWINDP 16.7 DEG.C		VOLTG 3.02 VOLTS		MEANBP 7000. KPA	TGRECH 488.0 DEG.C	T03HTR 561.1 DEG.C	
TDLDP 2.81 DEG.C				MEANCP 7034. KPA	TGREGC 101.2 DEG.C	T04HTR 543.9 DEG.C	
TWODPR 20.0 DEG.C					TGCOMP 59.0 DEG.C	T05HTR 545.9 DEG.C	
					TGBOUN 38.9 DEG.C	T06HTR 551.0 DEG.C	
						T07HTR 515.5 DEG.C	
						T08HTR 554.1 DEG.C	
						T09HTR 563.0 DEG.C	
HEAT TO COOLER	FLOCLR 4.23 L/MIN	CALCULATED PARAMETERS		VIBRATION	REMOTE CALCULATIONS	T10HTR 552.3 DEG.C	
TWINCL 25.1 DEG.C		1 PWRIIN 4107. WATTS		VX1HOR 0.4 CM/S	PWRROUT 919. WATTS	T11HTR 547.2 DEG.C	
TDLCL 9.24 DEG.C		2 QCOOLR 2715. WATTS		VY1IVER 9.1 CM/S	INDPWR 977. WATTS	T12HTR 550.8 DEG.C	
TWOCLR 34.47 DEG.C		3 QDSHPT 822. WATTS			PISTST 2.60 CM		
		4 EXTEFF 22.4 %			DISPST 2.19 CM		
		5 TAVHTR 549.5 DEG.C				T13REG***** DEG.C	
		6 INTEFF 25.3 %				T14REG 458.6 DEG.C	
		8 AMPS 1361. AMPS				T15REG 340.1 DEG.C	
		9 QDISPG 4. WATTS				T16REG***** DEG.C	
		10 QDISP 19. WATTS		ENGINE SPEED		T17REG 332.7 DEG.C	
		11 QREG1 99. WATTS		FREQ 31.7 HZ		T18REG 338.4 DEG.C	
		12 QREG2 97. WATTS				T19REG 216.6 DEG.C	
		13 QREG3 30. WATTS				T03HED***** DEG.C	
		14 PFP 1028.0 KPA/CM					
		15 PFD 276.9 KPA/CM					
		16 NBEALE 0.00621					

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 01/24/84 15:38:18.88 RDG 935

FLUID HELIUM		BAROM 14.263 PSI REGENERATOR 2 DISPLACER 2 STANDARD PISTON				SURFACE TEMPERATURES	
HEAT TO DASHPOT COOLING	FLODP 4.17 L/MIN	POWER IN	AMPS1 724. AMPS	ENGINE CHARGE PRESSURE	TGEXP 746.2 DEG.C	T01HTR 554.5 DEG.C	
			AMPS2 694. AMPS	PRESUP 7132. KPA		T02HTR 555.4 DEG.C	
TWINDP 16.7 DEG.C		VOLTG 3.15 VOLTS		MEANBP 6990. KPA	TGRECH 487.6 DEG.C	T03HTR 562.4 DEG.C	
TDLDP 2.99 DEG.C				MEANCP 7027. KPA	TGREGC 104.2 DEG.C	T04HTR 543.8 DEG.C	
TWODPR 20.3 DEG.C					TGCOMP 62.8 DEG.C	T05HTR 546.5 DEG.C	
					TGBOUN 40.0 DEG.C	T06HTR 551.5 DEG.C	
						T07HTR 514.7 DEG.C	
						T08HTR 554.7 DEG.C	
						T09HTR 564.6 DEG.C	
HEAT TO COOLER	FLOCLR 4.24 L/MIN	CALCULATED PARAMETERS		VIBRATION	REMOTE CALCULATIONS	T10HTR 553.5 DEG.C	
TWINCL 25.2 DEG.C		1 PWRIIN 4467. WATTS		VX1HOR 0.4 CM/S	PWRROUT 981. WATTS	T11HTR 548.3 DEG.C	
TDLCL 10.08 DEG.C		2 QCOOLR 2967. WATTS		VY1IVER 9.7 CM/S	INDPWR 1042. WATTS	T12HTR 550.7 DEG.C	
TWOCLR 35.43 DEG.C		3 QDSHPT 869. WATTS			PISTST 2.79 CM		
		4 EXTEFF 22.0 %			DISPST 2.30 CM		
		5 TAVHTR 550.1 DEG.C				T13REG***** DEG.C	
		6 INTEFF 24.9 %				T14REG 457.8 DEG.C	
		8 AMPS 1418. AMPS				T15REG 339.7 DEG.C	
		9 QDISPG 4. WATTS		ENGINE SPEED		T16REG***** DEG.C	
		10 QDISP 19. WATTS		FREQ 31.5 HZ		T17REG 335.1 DEG.C	
		11 QREG1 98. WATTS				T18REG 338.7 DEG.C	
		12 QREG2 97. WATTS				T19REG 218.3 DEG.C	
		13 QREG3 30. WATTS				T03HED***** DEG.C	
		14 PFP 1020.0 KPA/CM					
		15 PFD 263.5 KPA/CM					
		16 NBEALE 0.00621					

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 01/24/84 15:43:18.91 RDG 936

FLUID HELIUM		BAROM 14.263 PSI REGENERATOR 2 DISPLACER 2 STANDARD PISTON				SURFACE TEMPERATURES	
HEAT TO DASHPOT COOLING	FLODP 4.17 L/MIN	POWER IN	AMPS1 762. AMPS	ENGINE CHARGE PRESSURE	TGEXP 766.9 DEG.C	T01HTR 555.6 DEG.C	
			AMPS2 723. AMPS	PRESUP 7470. KPA		T02HTR 555.1 DEG.C	
TWINDP 16.7 DEG.C		VOLTG 3.30 VOLTS		MEANBP 7007. KPA	TGRECH 486.6 DEG.C	T03HTR 563.9 DEG.C	
TDLDP 3.27 DEG.C				MEANCP 7036. KPA	TGREGC 107.3 DEG.C	T04HTR 542.8 DEG.C	
TWODPR 20.5 DEG.C					TGCOMP 67.0 DEG.C	T05HTR 546.7 DEG.C	
					TGBOUN 41.2 DEG.C	T06HTR 551.8 DEG.C	
						T07HTR 513.0 DEG.C	
						T08HTR 554.7 DEG.C	
						T09HTR 565.1 DEG.C	
HEAT TO COOLER	FLOCLR 4.29 L/MIN	CALCULATED PARAMETERS		VIBRATION	REMOTE CALCULATIONS	T10HTR 554.8 DEG.C	
TWINCL 25.2 DEG.C		1 PWRIIN 4898. WATTS		VX1HOR 0.4 CM/S	PWRROUT 1051. WATTS	T11HTR 548.9 DEG.C	
TDLCL 11.07 DEG.C		2 QCOOLR 3294. WATTS		VY1IVER 10.3 CM/S	INDPWR 1113. WATTS	T12HTR 550.4 DEG.C	
TWOCLR 36.46 DEG.C		3 QDSHPT 949. WATTS			PISTST 2.99 CM		
		4 EXTEFF 21.5 %			DISPST 2.40 CM		
		5 TAVHTR 550.2 DEG.C				T13REG***** DEG.C	
		6 INTEFF 24.2 %				T14REG 457.2 DEG.C	
		8 AMPS 1485. AMPS				T15REG 339.7 DEG.C	
		9 QDISPG 4. WATTS		ENGINE SPEED		T16REG***** DEG.C	
		10 QDISP 20. WATTS		FREQ 31.5 HZ		T17REG 337.7 DEG.C	
		11 QREG1 95. WATTS				T18REG 338.1 DEG.C	
		12 QREG2 97. WATTS				T19REG 220.3 DEG.C	
		13 QREG3 29. WATTS				T03HED***** DEG.C	
		14 PFP 1027.2 KPA/CM					
		15 PFD 256.0 KPA/CM					
		16 NBEALE 0.00621					

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APPENDIX D. - CONTINUED.

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 01/24/84 15:48:18.91 RDG 937

FLUID HELIUM		BAROM 14.258 PSI REGENERATOR 2 DISPLACER 2 STANDARD PISTON			
HEAT TO DASHPOT COOLING		POWER IN	ENGINE CHARGE PRESSURE	GAS TEMPERATURES	SURFACE TEMPERATURES
FLODP	4.16 L/MIN	AMPS1 796. AMPS	PRESUP 7263. KPA	TGEXP 794.8 DEG.C	T01HTR 555.3 DEG.C
TWINDP	16.8 DEG.C	AMPS2 745. AMPS	MEANBP 6991. KPA	TGREGH 484.9 DEG.C	T02HTR 553.4 DEG.C
TDLDP	3.41 DEG.C	VOLTG 3.43 VOLTS	MEANCP 7052. KPA	TGREGC 109.6 DEG.C	T03HTR 563.6 DEG.C
TWODPR	20.9 DEG.C			TGCOMP 70.9 DEG.C	T04HTR 540.9 DEG.C
				TGBOUN 42.3 DEG.C	T05HTR 545.2 DEG.C
					T06HTR 550.7 DEG.C
					T07HTR 510.3 DEG.C
					T08HTR 553.8 DEG.C
					T09HTR 564.8 DEG.C
					T10HTR 554.3 DEG.C
					T11HTR 548.3 DEG.C
					T12HTR 548.8 DEG.C
HEAT TO COOLER		CALCULATED PARAMETERS	VIBRATION	REMOTE CALCULATIONS	
FLOCLR	4.29 L/MIN	1 PWRIN 5287. WATTS	VX1HOR 0.4 CM/S	PWRROUT 1119. WATTS	T13REG***** DEG.C
TWINCL	25.3 DEG.C	2 QCOOLR 3592. WATTS	VY1VER10.9 CM/S	INDPWR 1168. WATTS	T14REG 453.6 DEG.C
TDLCL	12.07 DEG.C	3 QDSHPT 987. WATTS		PISTST 3.19 CM	T15REG 337.9 DEG.C
TWOCLR	37.61 DEG.C	4 EXTEFF 21.2 %	PHASE ANGLES	DISPST 2.50 CM	T16REG***** DEG.C
		5 TAVHTR 549.1 DEG.C	PADISP 83.3 DEG.	PAMPC 1629. KPA	T17REG 338.8 DEG.C
		6 INTEFF 23.7 %	PAPRES -10.6 DEG.	DISPCP 2.78 CM	T18REG 337.9 DEG.C
		8 AMPS 1541. AMPS		PISTCP 2.26 CM	T19REG 222.1 DEG.C
		9 QDISPG 4. WATTS	ENGINE SPEED	PDYNDB 1675. KPA	
		10 QDISP 21. WATTS	FREQ 31.4 HZ	PDLCLR***** KPA	
		11 QREG1 94. WATTS		PDLREG***** KPA	
		12 QREG2 94. WATTS		PDLDIS***** KPA	
		13 QREG3 29. WATTS			T03HED***** DEG.C
		14 PFP 1024.9 KPA/CM			
		15 PFD 240.9 KPA/CM			
		16 NBEALE 0.00622			

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 01/24/84 15:51:21.91 RDG 938

FLUID HELIUM		BAROM 14.258 PSI REGENERATOR 2 DISPLACER 2 STANDARD PISTON			
HEAT TO DASHPOT COOLING		POWER IN	ENGINE CHARGE PRESSURE	GAS TEMPERATURES	SURFACE TEMPERATURES
FLODP	4.16 L/MIN	AMPS1 836. AMPS	PRESUP 7132. KPA	TGEXP 811.7 DEG.C	T01HTR 556.4 DEG.C
TWINDP	16.9 DEG.C	AMPS2 783. AMPS	MEANBP 7008. KPA	TGREGH 484.0 DEG.C	T02HTR 554.2 DEG.C
TDLDP	3.60 DEG.C	VOLTG 3.60 VOLTS	MEANCP 7069. KPA	TGREGC 113.0 DEG.C	T03HTR 565.6 DEG.C
TWODPR	21.1 DEG.C			TGCOMP 75.4 DEG.C	T04HTR 540.9 DEG.C
				TGBOUN 43.1 DEG.C	T05HTR 546.1 DEG.C
					T06HTR 551.1 DEG.C
					T07HTR 509.1 DEG.C
					T08HTR 555.1 DEG.C
					T09HTR 566.5 DEG.C
HEAT TO COOLER		CALCULATED PARAMETERS	VIBRATION	REMOTE CALCULATIONS	
FLOCLR	4.27 L/MIN	1 PWRIN 5831. WATTS	VX1HOR 0.5 CM/S	PWRROUT 1144. WATTS	T10HTR 555.6 DEG.C
TWINCL	25.4 DEG.C	2 QCOOLR 3944. WATTS	VY1VER11.6 CM/S	INDPWR 1191. WATTS	T11HTR 549.8 DEG.C
TDLCL	13.30 DEG.C	3 QDSHPT 1042. WATTS		PISTST 3.39 CM	T12HTR 549.4 DEG.C
TWOCLR	38.73 DEG.C	4 EXTEFF 19.6 %	PHASE ANGLES	DISPST 2.53 CM	
		5 TAVHTR 550.0 DEG.C	PADISP 84.5 DEG.	DYNAMIC CALCULATIONS	T13REG***** DEG.C
		6 INTEFF 22.5 %	PAPRES -9.7 DEG.	PAMPC 1747. KPA	T14REG 453.3 DEG.C
		8 AMPS 1618. AMPS		DISPCP 2.82 CM	T15REG 339.9 DEG.C
		9 QDISPG 4. WATTS	ENGINE SPEED	PISTCP 2.19 CM	T16REG***** DEG.C
		10 QDISP 21. WATTS	FREQ 31.4 HZ	PDYNDB 1763. KPA	T17REG 340.2 DEG.C
		11 QREG1 92. WATTS		PDLCLR***** KPA	T18REG 339.7 DEG.C
		12 QREG2 92. WATTS		PDLREG***** KPA	T19REG 226.3 DEG.C
		13 QREG3 29. WATTS		PDLDIS***** KPA	
		14 PFP 1032.2 KPA/CM			T03HED***** DEG.C
		15 PFD 234.0 KPA/CM			
		16 NBEALE 0.00597			

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 01/24/84 16:00:18.91 RDG 939

FLUID HELIUM		BAROM 14.258 PSI REGENERATOR 2 DISPLACER 2 STANDARD PISTON			
HEAT TO DASHPOT COOLING		POWER IN	ENGINE CHARGE PRESSURE	GAS TEMPERATURES	SURFACE TEMPERATURES
FLODP	4.20 L/MIN	AMPS1 564. AMPS	PRESUP 7105. KPA	TGEXP***** DEG.C	T01HTR 601.8 DEG.C
TWINDP	16.9 DEG.C	AMPS2 560. AMPS	MEANBP 6989. KPA	TGREGH 542.8 DEG.C	T02HTR 606.0 DEG.C
TDLDP	2.18 DEG.C	VOLTG 2.50 VOLTS	MEANCP 7025. KPA	TGREGC 93.8 DEG.C	T03HTR 609.0 DEG.C
TWODPR	19.5 DEG.C			TGCOMP 46.4 DEG.C	T04HTR 595.9 DEG.C
				TGBOUN 39.9 DEG.C	T05HTR 596.1 DEG.C
					T06HTR 603.7 DEG.C
					T07HTR 569.5 DEG.C
					T08HTR 606.4 DEG.C
HEAT TO COOLER		CALCULATED PARAMETERS	VIBRATION	REMOTE CALCULATIONS	
FLOCLR	4.24 L/MIN	1 PWRIN 2812. WATTS	VX1HOR 0.3 CM/S	PWRROUT 640. WATTS	T09HTR 609.0 DEG.C
TWINCL	24.9 DEG.C	2 QCOOLR 1842. WATTS	VY1VER 6.6 CM/S	INDPWR 695. WATTS	T10HTR 601.4 DEG.C
TDLCL	6.26 DEG.C	3 QDSHPT 637. WATTS		PISTST 1.79 CM	T11HTR 597.6 DEG.C
TWOCLR	31.39 DEG.C	4 EXTEFF 22.8 %	PHASE ANGLES	DISPST 1.73 CM	T12HTR 603.2 DEG.C
		5 TAVHTR 600.0 DEG.C	PADISP 82.5 DEG.	DYNAMIC CALCULATIONS	T13REG***** DEG.C
		6 INTEFF 25.8 %	PAPRES -18.2 DEG.	PAMPC 945. KPA	T14REG 505.8 DEG.C
		8 AMPS 1124. AMPS		DISPCP 2.60 CM	T15REG 371.1 DEG.C
		9 QDISPG***** WATTS	ENGINE SPEED	PISTCP 2.38 CM	T16REG***** DEG.C
		10 QDISP ***** WATTS	FREQ 32.3 HZ	PDYNDB 1088. KPA	T17REG 363.5 DEG.C
		11 QREG1 115. WATTS		PDLCLR***** KPA	T18REG 369.2 DEG.C
		12 QREG2 111. WATTS		PDLREG***** KPA	T19REG 227.3 DEG.C
		13 QREG3 35. WATTS		PDLDIS***** KPA	
		14 PFP 1044.0 KPA/CM			T03HED***** DEG.C
		15 PFD 343.2 KPA/CM			
		16 NBEALE 0.00615			

APPENDIX D. - CONTINUED.

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 01/24/84 16:05:21.91 RDG 940

FLUID HELIUM BAROM 14.258 PSI REGENERATOR 2 DISPLACER 2 STANDARD PISTON

HEAT TO DASHPOT COOLING FLODP 4.25 L/MIN	POWER IN AMPS1 619. AMPS AMPS2 577. AMPS	ENGINE CHARGE PRESSURE PRESUP 7476. KPA	GAS TEMPERATURES TGEXP1030.6 DEG.C	SURFACE TEMPERATURES T01HTR 599.3 DEG.C T02HTR 604.9 DEG.C
TWINDP 16.9 DEG.C TDLDP 2.15 DEG.C TWODPR 19.7 DEG.C	VOLTG 2.67 VOLTS	MEANBP 7007. KPA MEANCP 7052. KPA	TGREGH 537.5 DEG.C TGREGC 95.6 DEG.C TGCOMP 48.3 DEG.C TGBOUN 39.3 DEG.C	T03HTR 607.6 DEG.C T04HTR 593.1 DEG.C T05HTR 594.6 DEG.C T06HTR 599.8 DEG.C T07HTR 567.2 DEG.C T08HTR 603.1 DEG.C T09HTR 607.8 DEG.C T10HTR 599.0 DEG.C T11HTR 594.7 DEG.C T12HTR 600.9 DEG.C
HEAT TO COOLER FLOCRL 4.24 L/MIN TWINCL 24.8 DEG.C TDLCL 6.71 DEG.C TWOCLR 31.85 DEG.C	CALCULATED PARAMETERS 1 PWRIN 3189. WATTS 2 QCOOLR 1976. WATTS 3 QDSHPT 635. WATTS 4 EXTEFF 23.1 % 5 TAVHTR 597.7 DEG.C 6 INTEFF 27.2 % 8 AMPS 1196. AMPS 9 QDISPG 6. WATTS 10 QDISP 28. WATTS 11 QREG1 111. WATTS 12 QREG2 110. WATTS 13 QREG3 34. WATTS 14 PFP 1036.2 KPA/CM 15 PFD 332.4 KPA/CM 16 NBEALE 0.00638	VIBRATION VX1HOR 0.3 CM/S VY1VER 7.3 CM/S PHASE ANGLES PADISP 83.1 DEG. PAPRES -17.1 DEG. ENGINE SPEED FREQ 32.2 HZ	REMOTE CALCULATIONS PWRROUT 738. WATTS INDPWR 802. WATTS PISTST 2.00 CM DISPST 1.86 CM DYNAMIC CALCULATIONS PAMPC 1043. KPA DISPCP 2.62 CM PISTCP 2.43 CM PDYNDB 1163. KPA PDLCLR***** KPA PDLREG***** KPA PDLDIS***** KPA	T13REG***** DEG.C T14REG 503.9 DEG.C T15REG 372.4 DEG.C T16REG***** DEG.C T17REG 360.5 DEG.C T18REG 367.8 DEG.C T19REG 230.4 DEG.C T03HED***** DEG.C

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 01/24/84 16:10:18.91 RDG 941

FLUID HELIUM BAROM 14.258 PSI REGENERATOR 2 DISPLACER 2 STANDARD PISTON

HEAT TO DASHPOT COOLING FLODP 4.35 L/MIN	POWER IN AMPS1 660. AMPS AMPS2 601. AMPS	ENGINE CHARGE PRESSURE PRESUP 7124. KPA	GAS TEMPERATURES TGEXP 986.8 DEG.C	SURFACE TEMPERATURES T01HTR 601.7 DEG.C T02HTR 606.8 DEG.C
TWINDP 16.9 DEG.C TDLDP 2.28 DEG.C TWODPR 19.8 DEG.C	VOLTG 2.81 VOLTS	MEANBP 6999. KPA MEANCP 7045. KPA	TGREGH 536.7 DEG.C TGREGC 97.4 DEG.C TGCOMP 51.3 DEG.C TGBOUN 39.0 DEG.C	T03HTR 610.6 DEG.C T04HTR 594.1 DEG.C T05HTR 597.2 DEG.C T06HTR 601.5 DEG.C T07HTR 567.6 DEG.C T08HTR 604.3 DEG.C T09HTR 610.3 DEG.C
HEAT TO COOLER FLOCRL 4.22 L/MIN TWINCL 24.8 DEG.C TDLCL 7.51 DEG.C TWOCLR 32.55 DEG.C	CALCULATED PARAMETERS 1 PWRIN 3547. WATTS 2 QCOOLR 2199. WATTS 3 QDSHPT 690. WATTS 4 EXTEFF 23.2 % 5 TAVHTR 599.5 DEG.C 6 INTEFF 27.2 % 8 AMPS 1261. AMPS 9 QDISPG 5. WATTS 10 QDISP 27. WATTS 11 QREG1 110. WATTS 12 QREG2 110. WATTS 13 QREG3 34. WATTS 14 PFP 1025.3 KPA/CM 15 PFD 315.8 KPA/CM 16 NBEALE 0.00649	VIBRATION VX1HOR 0.4 CM/S VY1VER 7.9 CM/S PHASE ANGLES PADISP 83.9 DEG. PAPRES -15.8 DEG. ENGINE SPEED FREQ 32.2 HZ	REMOTE CALCULATIONS PWRROUT 822. WATTS INDPWR 892. WATTS PISTST 2.19 CM DISPST 1.97 CM DYNAMIC CALCULATIONS PAMPC 1132. KPA DISPCP 2.64 CM PISTCP 2.44 CM PDYNDB 1288. KPA PDLCLR***** KPA PDLREG***** KPA PDLDIS***** KPA	T13REG***** DEG.C T14REG 505.4 DEG.C T15REG 374.0 DEG.C T16REG***** DEG.C T17REG 360.6 DEG.C T18REG 369.3 DEG.C T19REG 233.3 DEG.C T03HED***** DEG.C

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 01/24/84 16:15:18.94 RDG 942

FLUID HELIUM BAROM 14.258 PSI REGENERATOR 2 DISPLACER 2 STANDARD PISTON

HEAT TO DASHPOT COOLING FLODP 4.34 L/MIN	POWER IN AMPS1 696. AMPS AMPS2 631. AMPS	ENGINE CHARGE PRESSURE PRESUP 7458. KPA	GAS TEMPERATURES TGEXP 951.3 DEG.C	SURFACE TEMPERATURES T01HTR 602.5 DEG.C T02HTR 607.0 DEG.C
TWINDP 16.9 DEG.C TDLDP 2.48 DEG.C TWODPR 20.0 DEG.C	VOLTG 2.96 VOLTS	MEANBP 6996. KPA MEANCP 7047. KPA	TGREGH 535.0 DEG.C TGREGC 100.2 DEG.C TGCOMP 54.6 DEG.C TGBOUN 39.4 DEG.C	T03HTR 612.0 DEG.C T04HTR 593.9 DEG.C T05HTR 597.7 DEG.C T06HTR 601.2 DEG.C T07HTR 566.7 DEG.C T08HTR 604.3 DEG.C T09HTR 611.7 DEG.C
HEAT TO COOLER FLOCRL 4.24 L/MIN TWINCL 24.9 DEG.C TDLCL 8.39 DEG.C TWOCLR 33.45 DEG.C	CALCULATED PARAMETERS 1 PWRIN 3929. WATTS 2 QCOOLR 2471. WATTS 3 QDSHPT 750. WATTS 4 EXTEFF 23.1 % 5 TAVHTR 599.8 DEG.C 6 INTEFF 26.9 % 8 AMPS 1327. AMPS 9 QDISPG 5. WATTS 10 QDISP 25. WATTS 11 QREG1 110. WATTS 12 QREG2 108. WATTS 13 QREG3 34. WATTS 14 PFP 1033.5 KPA/CM 15 PFD 308.4 KPA/CM 16 NBEALE 0.00659	VIBRATION VX1HOR 0.4 CM/S VY1VER 8.6 CM/S PHASE ANGLES PADISP 83.8 DEG. PAPRES -14.9 DEG. ENGINE SPEED FREQ 32.0 HZ	REMOTE CALCULATIONS PWRROUT 908. WATTS INDPWR 988. WATTS PISTST 2.40 CM DISPST 2.09 CM DYNAMIC CALCULATIONS PAMPC 1245. KPA DISCP 2.61 CM PISTCP 2.45 CM PDYNDB 1375. KPA PDLCLR***** KPA PDLREG***** KPA PDLDIS***** KPA	T13REG***** DEG.C T14REG 504.3 DEG.C T15REG 373.6 DEG.C T16REG***** DEG.C T17REG 360.1 DEG.C T18REG 370.5 DEG.C T19REG 234.8 DEG.C T03HED***** DEG.C

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APPENDIX D. - CONTINUED.

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 01/24/84 16:24:31.06 RDG 943

FLUID HELIUM BAROM 14.258 PSI REGENERATOR 2 DISPLACER 2 STANDARD PISTON

HEAT TO DASHPOT COOLING		POWER IN	ENGINE CHARGE PRESSURE	GAS TEMPERATURES	SURFACE TEMPERATURES
FLODP	4.34 L/MIN	AMPS1 730. AMPS	PRESUP 7459. KPA	TGEXP 900.7 DEG.C	T01HTR 602.5 DEG.C
		AMPS2 660. AMPS			T02HTR 605.8 DEG.C
TWINDP	16.9 DEG.C	VOLTG 3.10 VOLTS	MEANBP 7007. KPA	TGREGH 532.2 DEG.C	T03HTR 612.3 DEG.C
TDLDP	2.75 DEG.C		MEANCP 7059. KPA	TGREGC 103.1 DEG.C	T04HTR 592.2 DEG.C
TWODPR	20.3 DEG.C			TGCOMP 58.6 DEG.C	T05HTR 597.3 DEG.C
				TGBOUN 40.2 DEG.C	T06HTR 600.1 DEG.C
					T07HTR 564.5 DEG.C
					T08HTR 602.7 DEG.C
					T09HTR 611.6 DEG.C
					T10HTR 601.8 DEG.C
					T11HTR 595.6 DEG.C
					T12HTR 601.5 DEG.C
HEAT TO COOLER		CALCULATED PARAMETERS	VIBRATION	REMOTE CALCULATIONS	
FLOCLR	4.26 L/MIN	1 PWRIN 4314. WATTS	VX1HOR 0.5 CM/S	PWRROUT 1001. WATTS	T13REG***** DEG.C
TWINCL	25.0 DEG.C	2 QCOOLR 2723. WATTS	VY1VER 9.2 CM/S	INDPWR 1078. WATTS	T14REG 502.8 DEG.C
TDLCL	9.20 DEG.C	3 QDSHPT 831. WATTS		PISTST 2.59 CM	T15REG 373.7 DEG.C
TWOCLR	34.45 DEG.C	4 EXTEFF 23.2 %	PHASE ANGLES	DISPST 2.20 CM	T16REG***** DEG.C
		5 TAVHTR 599.0 DEG.C	PADISP 83.7 DEG.	DYNAMIC CALCULATIONS	T17REG 359.9 DEG.C
		6 INTEFF 26.9 %	PAPRES -14.3 DEG.	PAMPC 1339. KPA	T18REG 370.5 DEG.C
		8 AMPS 1390. AMPS		DISPCP 2.68 CM	T19REG 237.4 DEG.C
		9 QDISPG 5. WATTS	ENGINE SPEED	PISTCP 2.48 CM	
		10 QDISP 24. WATTS	FREQ 31.9 HZ	PDYNDB 1450. KPA	
		11 QREG1 108. WATTS		PDLCLR***** KPA	
		12 QREG2 107. WATTS		PDLREG***** KPA	
		13 QREG3 33. WATTS		PDLDIS***** KPA	
		14 PFP 1029.1 KPA/CM			T03HED***** DEG.C
		15 PFD 301.7 KPA/CM			
		16 NBEALE 0.00674			

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 01/24/84 16:28:19.08 RDG 944

FLUID HELIUM BAROM 14.258 PSI REGENERATOR 2 DISPLACER 2 STANDARD PISTON

HEAT TO DASHPOT COOLING		POWER IN	ENGINE CHARGE PRESSURE	GAS TEMPERATURES	SURFACE TEMPERATURE
FLODP	4.33 L/MIN	AMPS1 765. AMPS	PRESUP 7439. KPA	TGEXP 898.6 DEG.C	T01HTR 603.5 DEG.C
		AMPS2 689. AMPS			T02HTR 604.9 DEG.C
TWINLP	16.9 DEG.C	VOLTG 3.25 VOLTS	MEANBP 6982. KPA	TGREGH 532.0 DEG.C	T03HTR 612.9 DEG.C
TDLDP	2.97 DEG.C		MEANCP 7031. KPA	TGREGC 106.5 DEG.C	T04HTR 591.7 DEG.C
TWODPR	20.5 DEG.C			TGCOMP 62.7 DEG.C	T05HTR 596.8 DEG.C
				TGBOUN 40.7 DEG.C	T06HTR 599.9 DEG.C
					T07HTR 563.0 DEG.C
					T08HTR 603.2 DEG.C
					T09HTR 613.2 DEG.C
					T10HTR 602.7 DEG.C
					T11HTR 597.1 DEG.C
					T12HTR 600.1 DEG.C
HEAT TO COOLER		CALCULATED PARAMETERS	VIBRATION	REMOTE CALCULATIONS	
FLOCLR	4.27 L/MIN	1 PWRIN 4725. WATTS	VX1HOR 0.5 CM/S	PWRROUT 1095. WATTS	T13REG***** DEG.C
TWINCL	25.1 DEG.C	2 QCOOLR 2991. WATTS	VY1VER 9.9 CM/S	INDPWR 1171. WATTS	T14REG 501.0 DEG.C
TDLCL	10.10 DEG.C	3 QDSHPT 895. WATTS		PISTST 2.81 CM	T15REG 371.8 DEG.C
TWOCLR	35.40 DEG.C	4 EXTEFF 23.2 %	PHASE ANGLES	DISPST 2.32 CM	T16REG***** DEG.C
		5 TAVHTR 599.1 DEG.C	PADISP 82.5 DEG.	DYNAMIC CALCULATIONS	T17REG 362.9 DEG.C
		6 INTEFF 26.8 %	PAPRES -13.6 DEG.	PAMPC 1437. KPA	T18REG 367.9 DEG.C
		8 AMPS 1455. AMPS		DISPCP 2.70 CM	T19REG 237.5 DEG.C
		9 QDISPG 5. WATTS	ENGINE SPEED	PISTCP 2.46 CM	
		10 QDISP 24. WATTS	FREQ 31.6 HZ	PDYNDB 1500. KPA	
		11 QREG1 106. WATTS		PDLCLR***** KPA	
		12 QREG2 108. WATTS		PDLREG***** KPA	
		13 QREG3 33. WATTS		PDLDIS***** KPA	
		14 PFP 1026.6 KPA/CM			T03HED***** DEG.C
		15 PFD 294.4 KPA/CM			
		16 NBEALE 0.00688			

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 01/24/84 16:32:22.08 RDG 945

FLUID HELIUM BAROM 14.258 PSI REGENERATOR 2 DISPLACER 2 STANDARD PISTON

HEAT TO DASHPOT COOLING		POWER IN	ENGINE CHARGE PRESSURE	GAS TEMPERATURES	SURFACE TEMPERATURES
FLODP	4.32 L/MIN	AMPS1 803. AMPS	PRESUP 7141. KPA	TGEXP 921.7 DEG.C	T01HTR 604.3 DEG.C
		AMPS2 721. AMPS			T02HTR 604.0 DEG.C
TWINLP	17.0 DEG.C	VOLTG 3.40 VOLTS	MEANBP 7036. KPA	TGREGH 531.0 DEG.C	T03HTR 613.6 DEG.C
TDLDP	3.24 DEG.C		MEANCP 7105. KPA	TGREGC 110.4 DEG.C	T04HTR 590.8 DEG.C
TWODPR	20.8 DEG.C			TGCOMP 67.4 DEG.C	T05HTR 596.2 DEG.C
				TGBOUN 42.1 DEG.C	T06HTR 599.8 DEG.C
					T07HTR 560.6 DEG.C
					T08HTR 603.5 DEG.C
					T09HTR 614.0 DEG.C
					T10HTR 603.4 DEG.C
					T11HTR 597.8 DEG.C
					T12HTR 599.2 DEG.C
HEAT TO COOLER		CALCULATED PARAMETERS	VIBRATION	REMOTE CALCULATIONS	
FLOCLR	4.25 L/MIN	1 PWRIN 5185. WATTS	VX1HOR 0.5 CM/S	PWRROUT 1187. WATTS	T13REG***** DEG.C
TWINCL	25.1 DEG.C	2 QCOOLR 3303. WATTS	VY1VER 10.5 CM/S	INDPWR 1260. WATTS	T14REG 499.3 DEG.C
TDLCL	11.19 DEG.C	3 QDSHPT 975. WATTS		PISTST 2.99 CM	T15REG 370.6 DEG.C
TWOCLR	36.56 DEG.C	4 EXTEFF 22.9 %	PHASE ANGLES	DISPST 2.42 CM	T16REG***** DEG.C
		5 TAVHTR 598.9 DEG.C	PADISP 82.9 DEG.	DYNAMIC CALCULATIONS	T17REG 365.1 DEG.C
		6 INTEFF 26.4 %	PAPRES -12.8 DEG.	PAMPC 1540. KPA	T18REG 367.9 DEG.C
		8 AMPS 1524. AMPS		DISPCP 2.72 CM	T19REG 238.3 DEG.C
		9 QDISPG 5. WATTS	ENGINE SPEED	PISTCP 2.41 CM	
		10 QDISP 24. WATTS	FREQ 31.7 HZ	PDYNDB 1588. KPA	
		11 QREG1 105. WATTS		PDLCLR***** KPA	
		12 QREG2 107. WATTS		PDLREG***** KPA	
		13 QREG3 33. WATTS		PDLDIS***** KPA	
		14 PFP 1032.1 KPA/CM			T03HED***** DEG.C
		15 PFD 284.2 KPA/CM			
		16 NBEALE 0.00693			

APPENDIX D. - CONCLUDED.

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 01/24/84 16:35:28.08 RDG 946

FLUID HELIUM		BAROM 14.258 PSI REGENERATOR 2 DISPLACER 2 STANDARD PISTON				SURFACE TEMPERATURES	
HEAT TO DASHPOT COOLING	FLODP 4.30 L/MIN	POWER IN	AMPS1 829. AMPS	ENGINE CHARGE PRESSURE	TGEXP 969.6 DEG.C	T01HTR 607.8 DEG.C	
			AMPS2 758. AMPS	PRESUP 7448. KPA	TGREGH 531.8 DEG.C	T02HTR 603.5 DEG.C	
TWINDP 17.1 DEG.C	VOLTG 3.54 VOLTS			MEANBP 7005. KPA	TGREGC 113.5 DEG.C	T03HTR 616.3 DEG.C	
TDLDP 3.45 DEG.C				MEANCP 7072. KPA	TGCOMP 70.9 DEG.C	T04HTR 590.5 DEG.C	
TWODPR 21.1 DEG.C					TGBOUN 42.9 DEG.C	T05HTR 596.4 DEG.C	
						T06HTR 602.2 DEG.C	
						T07HTR 558.9 DEG.C	
						T08HTR 604.7 DEG.C	
						T09HTR 615.1 DEG.C	
HEAT TO COOLER	CALCULATED PARAMETERS	VIBRATION		REMOTE CALCULATIONS		T10HTR 606.8 DEG.C	
FLOCLR 4.27 L/MIN	1 PWRIN 5619. WATTS	VX1HOR 0.6 CM/S		PWRROUT 1274. WATTS		T11HTR 599.6 DEG.C	
TWINCL 25.2 DEG.C	2 QCOOLR 3587. WATTS	VY1VER11.2 CM/S		INDPWR 1348. WATTS		T12HTR 599.0 DEG.C	
TDLCL 12.10 DEG.C	3 QDSHPT 1034. WATTS			PISTST 3.19 CM			
TWOCLR 37.42 DEG.C	4 EXTEFF 22.7 %	PHASE ANGLES		DISPST 2.53 CM			
	5 TAVHTR 600.1 DEG.C	PADISP 82.1 DEG.	DYNAMIC CALCULATIONS				
	6 INTEFF 26.2 %	PAPRES -12.2 DEG.	PAMPC 1644. KPA				
	8 AMPS 1587. AMPS		DISPCP 2.80 CM				
	9 QDISPG 5. WATTS	ENGINE SPEED	PISTCP 2.30 CM				
	10 QDISP 26. WATTS	FREQ 31.6 HZ	PDYNDB 1700. KPA				
	11 QREG1 107. WATTS		PDLCLR***** KPA				
	12 QREG2 104. WATTS		PDLREG***** KPA				
	13 QREG3 32. WATTS		PDLDIS***** KPA				
	14 PFP 1036.2 KPA/CM						
	15 PFD 278.1 KPA/CM						
	16 NBEALE 0.00702						

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 01/24/84 16:37:28.08 RDG 947

FLUID HELIUM		BAROM 14.258 PSI REGENERATOR 2 DISPLACER 2 STANDARD PISTON				SURFACE TEMPERATURES	
HEAT TO DASHPOT COOLING	FLODP 4.33 L/MIN	POWER IN	AMPS1 844. AMPS	ENGINE CHARGE PRESSURE	TGEXP1005.3 DEG.C	T01HTR 608.8 DEG.C	
			AMPS2 805. AMPS	PRESUP 7445. KPA	TGREGH 531.1 DEG.C	T02HTR 603.4 DEG.C	
TWINDP 17.1 DEG.C	VOLTG 3.68 VOLTS			MEANBP 6998. KPA	TGREGC 117.2 DEG.C	T03HTR 617.5 DEG.C	
TDLDP 3.67 DEG.C				MEANCP 7074. KPA	TGCOMP 75.3 DEG.C	T04HTR 589.7 DEG.C	
TWODPR 21.4 DEG.C					TGBOUN 43.5 DEG.C	T05HTR 596.9 DEG.C	
						T06HTR 602.3 DEG.C	
						T07HTR 557.6 DEG.C	
						T08HTR 604.9 DEG.C	
						T09HTR 616.2 DEG.C	
HEAT TO COOLER	CALCULATED PARAMETERS	VIBRATION		REMOTE CALCULATIONS		T10HTR 607.7 DEG.C	
FLOCLR 4.27 L/MIN	1 PWRIN 6067. WATTS	VX1HOR 0.6 CM/S		PWRROUT 1340. WATTS		T11HTR 600.4 DEG.C	
TWINCL 25.2 DEG.C	2 QCOOLR 3910. WATTS	VY1VER11.8 CM/S		INDPWR 1410. WATTS		T12HTR 599.0 DEG.C	
TDLCL 13.21 DEG.C	3 QDSHPT 1106. WATTS			PISTST 3.38 CM			
TWOCLR 38.48 DEG.C	4 EXTEFF 22.1 %	PHASE ANGLES		DISPST 2.57 CM			
	5 TAVHTR 600.4 DEG.C	PADISP 82.4 DEG.	DYNAMIC CALCULATIONS				
	6 INTEFF 25.5 %	PAPRES -11.4 DEG.	PAMPC 1757. KPA				
	8 AMPS 1649. AMPS		DISPCP 2.82 CM				
	9 QDISPG 5. WATTS	ENGINE SPEED	PISTCP 2.19 CM				
	10 QDISP 26. WATTS	FREQ 31.6 HZ	PDYNDB 1763. KPA				
	11 QREG1 105. WATTS		PDLCLR***** KPA				
	12 QREG2 103. WATTS		PDLREG***** KPA				
	13 QREG3 32. WATTS		PDLDIS***** KPA				
	14 PFP 1046.3 KPA/CM						
	15 PFD 272.4 KPA/CM						
	16 NBEALE 0.00697						

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 01/24/84 16:40:31.08 RDG 948

FLUID HELIUM		BAROM 14.258 PSI REGENERATOR 2 DISPLACER 2 STANDARD PISTON				SURFACE TEMPERATURES	
HEAT TO DASHPOT COOLING	FLODP 4.31 L/MIN	POWER IN	AMPS1 859. AMPS	ENGINE CHARGE PRESSURE	TGEXP 605.1 DEG.C	T01HTR 612.9 DEG.C	
			AMPS2 865. AMPS	PRESUP 7112. KPA	TGREGH 532.2 DEG.C	T02HTR 607.0 DEG.C	
TWINDP 17.2 DEG.C	VOLTG 3.86 VOLTS			MEANBP 6998. KPA	TGREGC 121.7 DEG.C	T03HTR 622.4 DEG.C	
TDLDP 3.92 DEG.C				MEANCP 7094. KPA	TGCOMP 80.3 DEG.C	T04HTR 592.7 DEG.C	
TWODPR 21.7 DEG.C					TGBOUN 44.7 DEG.C	T05HTR 601.0 DEG.C	
						T06HTR 605.5 DEG.C	
						T07HTR 559.8 DEG.C	
						T08HTR 608.5 DEG.C	
						T09HTR 621.0 DEG.C	
HEAT TO COOLER	CALCULATED PARAMETERS	VIBRATION		REMOTE CALCULATIONS		T10HTR 612.1 DEG.C	
FLOCLR 4.28 L/MIN	1 PWRIN 6649. WATTS	VX1HOR 0.6 CM/S		PWRROUT 1400. WATTS		T11HTR 604.4 DEG.C	
TWINCL 25.2 DEG.C	2 QCOOLR 4363. WATTS	VY1VER12.5 CM/S		INDPWR 1495. WATTS		T12HTR 602.3 DEG.C	
TDLCL 14.69 DEG.C	3 QDSHPT 1176. WATTS			PISTST 3.60 CM			
TWOCLR 39.99 DEG.C	4 EXTEFF 21.1 %	PHASE ANGLES		DISPST 2.58 CM			
	5 TAVHTR 604.1 DEG.C	PADISP 81.6 DEG.	DYNAMIC CALCULATIONS				
	6 INTEFF 24.3 %	PAPRES -10.7 DEG.	PAMPC 1919. KPA				
	8 AMPS 1724. AMPS		DISPCP 2.89 CM				
	9 QDISPG 3. WATTS	ENGINE SPEED	PISTCP 2.04 CM				
	10 QDISP 15. WATTS	FREQ 31.7 HZ	PDYNDB 1888. KPA				
	11 QREG1 102. WATTS		PDLCLR***** KPA				
	12 QREG2 103. WATTS		PDLREG***** KPA				
	13 QREG3 32. WATTS		PDLDIS***** KPA				
	14 PFP 1077.5 KPA/CM						
	15 PFD 279.5 KPA/CM						
	16 NBEALE 0.00683						

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TABLE I. - NUMBER OF DATA POINTS PER CONFIGURATION

[Regenerator and displacer 1 were designed for high efficiency. Regenerator and displacer 2 were designed for high power.]

Regenerator	Displacer	Power piston	Working fluid	Number of data points
No. 1	No. 1	Std	Helium	150
No. 1	No. 2			174
No. 2	No. 2			189
No. 2	No. 1			108
No. 1			Argon	12
No. 1			Nitrogen	64
No. 1		Light	Helium	84

TABLE II. - DESCRIPTION OF THE GEOMETRY OF THE RE-1000

Number of cylinders	1
Housing weight, Kg (lb)	416 (917)
Type	free-piston with dashpot
Design working fluid	helium
Design frequency, Hz	30
Design pressure, Mpa	7.0
Bounce space volume, cm ³ (in. ³)	20,500 (1250)
Design power, W	1000
Design displacer phase angle	45
Cylinder bore, cm (in.)	5.722 (2.2527)
Maximum displacer 1 stroke, cm (in.)	4.01 (1.579)
Displacer 1 length, cm (in.)	15.21 (5.99)
Maximum displacer 2 stroke, cm (in.)	5.18 (2.039)
Displacer 2 length, cm (in.)	14.05 (5.53)
Maximum power piston stroke, cm (in.)	4.35 (1.713)
Cooler	
Description	135 rectangular gas passages
Passage width, cm (in.)	0.0508 (0.020)
Passage depth, cm (in.)	0.376 (0.148)
Length, cm (in.)	7.92 (3.118)
Flow area, cm ² (in. ²)	2.58 (0.400)
Wetted perimeter, cm (in.)	115.2 (45.354)
Volume, cm ³ (in. ³)	20.42 (1.246)
Heater	
Description	tubular
Tube material	Inconel 718
Number of tubes	34
Tube length, cm (in.)	18.34 (7.220)
Tube inside diameter, mm (in.)	2.362 (0.093)
Tube outside diameter, mm (in.)	3.175 (0.125)
Design maximum wall temperature, °C (°F)	650 (1202)
Regenerator	
Length containing wire mesh, cm (in.)	6.446 (2.538)
Outside diameter, cm (in.)	7.18 (2.825)
Inside diameter, cm (in.)	6.07 (2.391)
Inner wall thickness, cm (in.)	0.13 (0.05)
Matrix material	304SS Metex
Wire diameter, mm (in.)	0.0889 (0.0035)
Porosity, regenerator 1, percent	75.9
Porosity, regenerator 2, percent	81.2
Weight of matrix, regenerator 1, g (lb)	139 (0.31)
Weight of matrix, regenerator 2, g (lb)	108 (0.24)
Pistons	
Standard power piston oscillating mass, kg (lb)	5.97 (13.17)
Light power piston oscillating mass, kg (lb)	3.48 (7.67)
Power piston diameter, cm (in.)	5.718 (2.2514)

TABLE II. - Continued

Displacer 1 mass, kg (lb)	. . . . .	0.426 (0.939)
Displacer 1 diameter, cm (in.)	. . . . .	5.67 (2.232)
Displacer 1 rod diameter, cm (in.)	. . . . .	1.663 (0.6548)
Displacer 1 bore, cm (in.)	. . . . .	1.666 (0.6560)
Displacer 2 mass, kg (lb)	. . . . .	0.381 (0.840)
Displacer 2 diameter, cm (in.)	. . . . .	5.67 (2.232)
Displacer 2 rod diameter, cm (in.)	. . . . .	1.806 (0.7110)
Displacer 2 bore, cm (in.)	. . . . .	1.808 (0.7118)
Dead volumes		
Displacer 1/cylinder annular gap, cm ³ (in. ³)	. . . . .	9.83 (0.60)
Displacer 2/cylinder annular gap, cm ³ (in. ³)	. . . . .	8.36 (0.51)
Expansion space instrumentation ports, cm ³ (in. ³)	. . . . .	1.64 (0.10)
Expansion space to heater tube junction, cm ³ (in. ³)	. . . . .	3.80 (0.23)
Heater tubes, cm ³ (in. ³)	. . . . .	27.4 (1.67)
Heater tube to regenerator plenum junction, cm ³ (in. ³)	. . . . .	5.90 (0.36)
Regenerator hot end plenum, cm ³ (in. ³)	. . . . .	4.10 (0.25)
Regenerator plenum ring, cm ³ (in. ³)	. . . . .	0.83 (0.05)
Instrumentation ports (heater/regenerator), cm ³ (in. ³)	. . . . .	1.64 (0.10)
Regenerator 1, cm ³ (in. ³)	. . . . .	56.1 (3.42)
Regenerator 2, cm ³ (in. ³)	. . . . .	69.1 (3.67)
Regenerator cold end plenum, cm ³ (in. ³)	. . . . .	4.23 (0.26)
Instrumentation ports (regenerator/cooler), cm ³ (in. ³)	. . . . .	3.41 (0.21)
Cooler, cm ³ (in. ³)	. . . . .	20.42 (1.25)
Cooler plenum at the compression space, cm ³ (in. ³)	. . . . .	7.15 (0.44)
Compression space instrumentation ports, cm ³ (in. ³)	. . . . .	3.15 (0.19)
Cylinder ports, cm ³ (in. ³)	. . . . .	1.21 (0.07)
Piston/spider clearance, cm ³ (in. ³)	. . . . .	18.4 (1.21)
Annular ring around the spider, cm ³ (in. ³)	. . . . .	3.82 (0.23)
Displacer LVDT core, cm ³ (in. ³)	. . . . .	2.95 (0.18)
Power piston center port, cm ³ (in. ³)	. . . . .	5.90 (0.36)
Materials		
Heater head		
Regenerator outer cylinder	. . . . .	316SS
Expansion space dome	. . . . .	316SS
Regenerator inner cylinder wall	. . . . .	316SS
Displacer	. . . . .	321SS
Cooler	. . . . .	6061-T6 Al
Cylinder		
Power piston	. . . . .	6061-T6 Al with chrome oxide coating
Displacer	. . . . .	304SS with chrome oxide coating
Standard power piston	. . . . .	6061-T6 Al body with Xylan Coating and mild steel mass
Light power piston	. . . . .	6061-T6 Al body with Xylan coating and Al mass
Diametral clearances		
Displacer 1 rod/rod cylinder, mm (in.)	. . . . .	0.030 (0.0012)
Displacer 1 body/displacer cylinder, mm (in.)	. . . . .	0.381 (0.015)
Displacer 2 rod/rod cylinder, mm (in.)	. . . . .	0.020 (0.0008)
Displacer 2 body/displacer cylinder, mm (in.)	. . . . .	0.381 (0.015)
Power piston/piston cylinder, mm (in.)	. . . . .	0.033 (0.001)

TABLE II. - Concluded

Displacer gas spring

No. 1 design mean volume, cm ³ (in. ³)	31.79 (1.94)
No. 1 rod diameter, cm (in.)	1.663 (0.655)
No. 2 design mean volume, cm ³ (in. ³)	18.8 (1.147)
No. 2 rod diameter, cm (in.)	1.806 (0.711)

Center ports

Power piston port location, distance from inward limit to center port opening position, cm (in.)	2.05 (0.81)
Displacer 1, distance from expansion space limit to position where the center port opens, cm (in.)	1.90 (0.75)
Displacer 2, distance from expansion space limit to position where the center port opens, cm (in.)	2.64 (1.04)
Center port diameter, power piston, mm (in.)	1.1 (0.042)
Center port diameter, displacers, mm (in.)	1.0 (0.040)

TABLE III. - RE-1000 ENGINE VOLUMES WHEN THE PISTON
AND DISPLACER AT THEIR CENTER PORT POSITIONS

	cm ³ (in. ³)
Expansion space	
Clearance around displacer 1	9.83 (0.60)
Clearance around displacer 2	8.36 (0.51)
Between the displacer and the end of the cylinder	50.1 (3.06)
Instrumentation ports	1.64 (0.10)
Total with D1	61.6 (3.76)
Expansion-heater connecting duct	
Expansion to heater tube junction	3.80 (0.232)
Heater assembly	
Heated portion of the tubes	27.4 (1.67)
Heater-regenerator duct	
Heater tube to regenerator plenum junction	5.90 (0.360)
Regenerator hot end plenum	4.10 (0.250)
Regenerator plenum ring	0.83 (0.051)
Instrumentation ports	1.64 (0.10)
Total	12.47 (0.761)
Regenerator	
Regenerator dead volume R1	56.1 (3.42)
Regenerator dead volume R2	60.1 (3.67)
Regenerator-cooler duct	
Regenerator cold end plenum ring	0.84 (0.051)
Regenerator cold end plenum	4.23 (0.258)
Instrumentation ports	0.93 (0.057)
Heater flange fittings	3.41 (0.208)
Total	9.41 (0.574)
Cooler	
Cooler passages	20.4 (1.25)
Cooler-compression space duct	
Cooler plenum at compression space	7.14 (0.436)
Cylinder ports	1.21 (0.074)
Total	8.36 (0.510)
Compression space	
Between displacer and spider with D1	49.0 (2.99)
Between displacer and spider with D2	58.5 (3.57)
From piston to spider passages	16.06 (0.98)
Annular space around spider	3.82 (0.23)
Between power piston and spider	18.4 (1.12)
Power piston centering port passage	5.90 (0.36)
Displacer LVDT inside of piston	2.95 (0.18)
Anti rotation rod clearance holes	5.16 (0.32)
Instrumentation ports	3.15 (0.19)
Total with D1	104.4 (6.37)

TABLE IV. - RE-1000 INSTRUMENTATION

Mnemonic	Parameter	Range	Type	SS	V	E ₊
1 MEANCP	Mean comp space pressure, kPa	0-13800	Strain gauge	X	20	
2 MEANBP	Mean bounce pressure, kPa	0-1380	Strain gauge		20	
3 PRESUP	Gas supply pressure, kPa	0-13800	Strain gauge		20	
4 T01HTR	Heater tube metal temp, °C	400-825	Thermocouple		10	
5 T02HTR						
6 T03HTR						
7 T04HTR						
8 T05HTR						
9 T06HTR						
10 T07HTR						
11 T08HTR						
12 T09HTR						
13 T10HTR						
14 T11HTR						
15 T12HTR						
16 T03HED	Head metal temp, °C					
17 T13REG	Regen. vert. profile, °C					
18 T14REG	Regen. vert. profile, °C					
19 T15REG	Regen. circular profile, °C	250-825			5	
20 T16REG						
21 T17REG						
22 T18REG						
23 T19REG	Regen. vert. profile, °C	20-250			1	
24 TGBOUN	Regen. vert. profile, °C	20-80				
25 TGCOMP	Comp. space gas temp, °C	20-250				
26 TGREGC	Regen.-cooler gas temp, °C	20-250				
27 TGREGH	Regen.-heater gas temp, °C	400-825			10	
28 TGEXP	Expansion space gas temp, °C	400-825			10	
29 TWINDP	Dashpot water inlet temp, °C	10-70			1	
30 TDLDP	Dashpot water delta temp, °C	0-20			0.2	
31 TWODP	Dashpot water outlet temp, °C	10-70			1	
32 TWINCL	Cooler water inlet temp, °C	10-70			1	
33 IDLCL	Cooler water delta temp, °C	0-20			0.2	
34 TWOCL	Cooler outlet temp, °C	10-70			0.2	
35 AMPS1	Heater amps, supply 1, A	0-1000	Ammeter		10	
36 AMPS2	Heater amps, supply 2, A	0-1000	Ammeter		10	
37 VOLTG	Heater voltage, V	0-20	Voltmeter		0.01	
38 FLOORP						
39 FLOCLR	Dashpot water flow, l/min	0-10	Turbine meter		0.1	
40 VXTHOR	Cooler water flow, l/min	0-10	Turbine meter			
41 VY1VER	Horiz. vibration, cm/sec	0-3.8	Accelerometer			
42 PISTST	Vert. vibration, cm/sec	0-3.8	Accelerometer			
	Piston stroke, cm	0-4	Stroke meter		0.02	
43 DISPST	Displacer stroke, cm	0-4	Stroke meter		0.02	
44 INDPWR	Indicated power, W	0-3000	Analog circ.		40	
45 PWROUT	Brake power, kW	0-3.0	Analog circ.		40	
46 FPIST	Load force on piston, N	0-1600	F transducer	X	20	
47 XPIST	Piston position, cm	+2.0	LVDT	X	0.02	

TABLE IV. - Concluded

Mnemonic	Parameter	Range	Type	SS	V	E _±
48 XDOTP	Piston velocity, m/sec	±8.0	LVT	X	0.1	
49 XDISP	Displacer position, cm	±2.0	LVDT			0.04
50 PDYNC	Comp. space pressure, kPa	±2000	Crystal		10	
51 PDLCLR	Cooler delta pressure, kPa	68.9	Diff. P xducer		2.5	
52 PDLREG	Regen. delta pressure, kPa	138	Diff. P xducer	X	5	
53 POLDIS	Displacer delta pressure, kPa	138	Diff. P xducer		5	
54 PDYNDB	Disp. gas spring press., MPa	10.0	Strain gauge			0.1
55 PAPRES	Phase angle of pressure, deg	0-360	Phase meter	X	1	
56 PADISP	Phase angle of displacer, deg	0-360	Phase meter	X	1	
57 FREQ	Engine frequency, Hz	0-50	Freq. to dc	X		0.05
58 PAMPC	Comp. pressure ampl., kPa	0-2000	Crystal	X	20	

TABLE V. - RE-1000 CALCULATIONS

Mnemonic	Description of the calculation
PWRIN	Electric power input to the heater head
QCoolR	Heat rejected by the engine cooler
QDSHPT	Heat rejected by the dashpot
EXTEFF	Engine efficiency based on the brake power output and the heater power input
TAVHTR	Average heater tube outside temperature
INTEFF	Engine efficiency based on the brake power output and brake power plus QCoolR used as the input
AMPS	Total amperage to the heater head
QDISPG	Heat conduction through the gas in the displacer
QDISP	Heat conduction through the displacer body
QREG1	Outer regenerator wall conduction
QREG2	Outer regenerator wall conduction
QREG3	Inner regenerator wall conduction
PWROUT	Brake power output, analog calculation
INDPWR	Indicated power output, analog calculation
PISTST	Power piston stroke
DISPST	Displacer stroke

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TABLE VI. - RE-1000 SAMPLE DATA POINTS SINGLE VARIABLE DATA SET

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 11/17/83 10:17:21.80 RDG 602

FLUID HELIUM		BAROM 14.268 PSI		REGENERATOR 2 DISPLACER 1 STANDARD PISTON		SURFACE TEMPERATURES	
HEAT TO DASHPOT COOLING	FLODP 4.10 L/MIN	POWER IN		ENGINE CHARGE PRESSURE		GAS TEMPERATURES	
		AMPS1 776. AMPS		PRESUP 7482. KPA		TGEXP 554.8 DEG.C	T01HTR 609.3 DEG.C
		AMPS2 651. AMPS					T02HTR 609.9 DEG.C
		VOLTG 3.11 VOLTS		MEANBP 7013. KPA		TGRECH 547.0 DEG.C	T03HTR 619.7 DEG.C
				MEANCP 7056. KPA		TGREGC 101.9 DEG.C	T04HTR 594.3 DEG.C
						TGCOMP 61.6 DEG.C	T05HTR 604.4 DEG.C
						TGBOUN 36.9 DEG.C	T06HTR 602.3 DEG.C
							T07HTR 573.2 DEG.C
							T08HTR 605.9 DEG.C
HEAT TO COOLER	FLOCLR 4.17 L/MIN	CALCULATED PARAMETERS		VIBRATION		REMOTE CALCULATIONS	
		1 PWRRIN 4433. WATTS		VX1HOR 0.5 CM/S		PWRROUT 1216. WATTS	T09HTR 619.2 DEG.C
		2 QCoolR 2789. WATTS		VY1VER 8.5 CM/S		INDEUR 1262. WATTS	T10HTR 546.2 DEG.C
		3 QDSHPT 840. WATTS				PISTST 2.58 CM	T11HTR 603.4 DEG.C
		4 EXTEFF 27.4 %		PHASE ANGLES		DISPST 2.72 CM	T12HTR 603.9 DEG.C
		5 TAVHTR 599.3 DEG.C		PADISP 57.1 DEG.			T13REG 553.7 DEG.C
		6 INTEFF 30.4 %		PAPRES -21.6 DEG.			T14REG 514.8 DEG.C
		8 AMPS 1427. AMPS		ENGINE SPEED		DYNAMIC CALCULATIONS	
		9 QDISPG 3. WATTS		FREQ 29.9 HZ		PAMPC 1127. KPA	T15REG 376.7 DEG.C
		10 QDISP 14. WATTS				DISPCP 2.11 CM	T16REG**** DEG.C
		11 QREG1 106. WATTS				PISTCP 2.64 CM	T17REG 355.8 DEG.C
		12 QREG2 121. WATTS				PDYNDB***** KPA	T18REG 366.0 DEG.C
		13 QREG3 34. WATTS				PDLCLR***** KPA	T19REG 235.5 DEG.C
		14 PFP 1019.5 KPA/CM				PDLREG***** KPA	
		15 PFD 362.7 KPA/CM				PDLDIS***** KPA	
		16 NBEALE 0.00875					T03HED 293.5 DEG.C

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 07/26/84 15:35:55.03 RDG 1006

FLUID HELIUM		BAROM 14.303 PSI		REGENERATOR 1 DISPLACER 1 STANDARD PISTON		SURFACE TEMPERATURES	
HEAT TO DASHPOT COOLING	FLODP 3.96 L/MIN	POWER IN		ENGINE CHARGE PRESSURE		GAS TEMPERATURES	
		AMPS1 534. AMPS		PRESUP 7365. KPA		TGEXP 567.8 DEG.C	T01HTR 601.6 DEG.C
		AMPS2 503. AMPS					T02HTR 605.5 DEG.C
		VOLTG 2.25 VOLTS		MEANBP 7011. KPA		TGRECH 564.5 DEG.C	T03HTR 612.6 DEG.C
				MEANCP 7040. KPA		TGREGC 90.7 DEG.C	T04HTR 606.4 DEG.C
						TGCOMP 39.9 DEG.C	T05HTR 61.3 DEG.C
						TGBOUN 27.9 DEG.C	T06HTR 606.3 DEG.C
HEAT TO COOLER	FLOCLR 4.22 L/MIN	CALCULATED PARAMETERS		VIBRATION		REMOTE CALCULATIONS	
		1 PWRRIN 2338. WATTS		VX1HOR 0.2 CM/S		PWRROUT 532. WATTS	T07HTR 604.5 DEG.C
		2 QCoolR 1892. WATTS		VY1VER 5.9 CM/S		INDPWR 570. WATTS	T08HTR 584.1 DEG.C
		3 QDSHPT 317. WATTS				PISTST 1.80 CM	T09HTR 608.8 DEG.C
		4 EXTEFF 22.7 %		PHASE ANGLES		DISPST 1.83 CM	T10HTR 591.8 DEG.C
		5 TAVHTR 599.6 DEG.C		PADISP 56.0 DEG.			T11HTR 578.7 DEG.C
		6 INTEFF 21.9 %		PAPRES -19.8 DEG.		DYNAMIC CALCULATIONS	
		8 AMPS 1037. AMPS		ENGINE SPEED		PAMPC 792. KPA	T12HTR 580.2 DEG.C
		9 QDISPG 3. WATTS		FREQ 30.2 HZ		DISPCP 2.13 CM	T13REG***** DEG.C
		10 QDISP 15. WATTS				PISTCP 2.31 CM	T14REG 518.3 DEG.C
		11 QREG1 119. WATTS				PDYNDB***** KPA	T15REG 384.4 DEG.C
		12 QREG2 118. WATTS				PDLCLR 3.22 KPA	T16REG 386.7 DEG.C
		13 QREG3 37. WATTS				PDLREG 37.33 KPA	T17REG 376.6 DEG.C
		14 PFP 1029.1 KPA/CM				PDLDIS 65.16 KPA	T18REG 372.8 DEG.C
		15 PFD 353.7 KPA/CM					T19REG 225.5 DEG.C
		16 NBEALE 0.00544					T03HED***** DEG.C

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 07/26/84 15:40:22.06 RDG 1007

FLUID HELIUM		BAROM 14.303 PSI		REGENERATOR 1 DISPLACER 1 STANDARD PISTON		SURFACE TEMPERATURES	
HEAT TO DASHPOT COOLING	FLODP 3.94 L/MIN	POWER IN		ENGINE CHARGE PRESSURE		GAS TEMPERATURES	
		AMPS1 571. AMPS		PRESUP 7469. KPA		TGEXP 564.8 DEG.C	T01HTR 602.6 DEG.C
		AMPS2 533. AMPS					T02HTR 605.0 DEG.C
		VOLTG 2.40 VOLTS		MEANBP 6982. KPA		TGRECH 563.7 DEG.C	T03HTR 613.7 DEG.C
				MEANCP 7013. KPA		TGREGC 92.6 DEG.C	T04HTR 605.5 DEG.C
						TGCOMP 42.0 DEG.C	T05HTR 615.7 DEG.C
						TGBOUN 29.0 DEG.C	T06HTR 607.1 DEG.C
HEAT TO COOLER	FLOCLR 4.24 L/MIN	CALCULATED PARAMETERS		VIBRATION		REMOTE CALCULATIONS	
		1 PWRRIN 2648. WATTS		VX1HOR 0.3 CM/S		PWRROUT 622. WATTS	T07HTR 605.4 DEG.C
		2 QCoolR 2004. WATTS		VY1VER 6.6 CM/S		INDPWR 665. WATTS	T08HTR 583.8 DEG.C
		3 QDSHPT 390. WATTS				PISTST 2.01 CM	T09HTR 609.7 DEG.C
		4 EXTEFF 23.5 %		PHASE ANGLES		DISPST 1.97 CM	T10HTR 590.4 DEG.C
		5 TAVHTR 599.5 DEG.C		PADISP 56.6 DEG.			T11HTR 577.8 DEG.C
		6 INTEFF 23.7 %		PAPRES -18.9 DEG.		DYNAMIC CALCULATIONS	
		8 AMPS 1104. AMPS		ENGINE SPEED		PAMPC 881. KPA	T12HTR 577.7 DEG.C
		9 QDISPG 3. WATTS		FREQ 30.2 HZ		DISPCP 2.24 CM	T13REG***** DEG.C
		10 QDISP 15. WATTS				PISTCP 2.34 CM	T14REG 517.9 DEG.C
		11 QREG1 118. WATTS				PDYNDB***** KPA	T15REG 385.7 DEG.C
		12 QREG2 117. WATTS				PDLCLR 3.73 KPA	T16REG 388.3 DEG.C
		13 QREG3 36. WATTS				PDLREG 42.43 KPA	T17REG 377.9 DEG.C
		14 PFP 1018.7 KPA/CM				PDLDIS 73.65 KPA	T18REG 373.3 DEG.C
		15 PFD 345.8 KPA/CM					T19REG 228.0 DEG.C
		16 NBEALE 0.00573					T03HED***** DEG.C

TABLE VI. - CONTINUED.

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 07/26/84 15:46:40.06 RDG 1008

FLUID HELIUM		BAROM 14.303 PSI		REGENERATOR 1	DISPLACER 1	STANDARD PISTON	
HEAT TO DASHPOT COOLING	FLODP 3.94 L/MIN	POWER IN		ENGINE CHARGE PRESSURE		GAS TEMPERATURES	SURFACE TEMPERATURES
		AMPS1 604. AMPS		PRESUP 7055. KPA		TGEXP 562.6 DEG.C	T01HTR 603.8 DEG.C
		AMPS2 357. AMPS				TGREGH 563.2 DEG.C	T02HTR 604.7 DEG.C
TWINDP 17.8 DEG.C		VOLTG 2.53 VOLTS		MEANBP 6988. KPA		TGREGC 94.9 DEG.C	T03HTR 615.3 DEG.C
TDLDP 1.72 DEG.C				MEANCP 7023. KPA		TGCOMP 45.4 DEG.C	T04HTR 605.1 DEG.C
TWODPR 20.2 DEG.C						TGBOUN 30.6 DEG.C	T05HTR 617.5 DEG.C
							T06HTR 608.2 DEG.C
							T07HTR 606.3 DEG.C
							T08HTR 584.0 DEG.C
							T09HTR 610.7 DEG.C
HEAT TO COOLER	FLOCLR 4.23 L/MIN	CALCULATED PARAMETERS		VIBRATION		REMOTE CALCULATIONS	T10HTR 589.5 DEG.C
TWINCL 24.7 DEG.C		1 PWRIN 2930. WATTS		VX1HOR 0.3 CM/S		PWRROUT 703. WATTS	T11HTR 577.5 DEG.C
TDLCL 7.61 DEG.C		2 QCoolR 2233. WATTS		VY1VER 7.2 CM/S		INDPWR 753. WATTS	T12HTR 576.1 DEG.C
TWOCLR 30.73 DEG.C		3 QDShpt 470. WATTS				PISTST 2.20 CM	
		4 EXTEFF 24.0 %		PHASE ANGLES		DISPST 2.09 CM	
		5 TAVHTR 599.9 DEG.C		PADISP 56.7 DEG.			T13REG***** DEG.C
		6 INTEFF 23.9 %		PAPRES -17.7 DEG.			T14REG 518.7 DEG.C
		8 AMPS 1160. AMPS				DYNAMIC CALCULATIONS	T15REG 388.8 DEG.C
		9 QDISPG 3. WATTS		ENGINE SPEED		PAMPC 979. KPA	T16REG 389.2 DEG.C
		10 QDISP 15. WATTS		FREQ 30.2 Hz		DISPCP 2.27 CM	T17REG 380.1 DEG.C
		11 QREG1 117. WATTS				PISTCP 2.34 CM	T18REG 376.6 DEG.C
		12 QREG2 115. WATTS				PDYNDB***** KPA	T19REG 232.8 DEG.C
		13 QREG3 36. WATTS				PDLCLR 4.07 KPA	
		14 PFP 1025.2 KPA/CM				PDLREG 47.86 KPA	
		15 PFD 339.6 KPA/CM				PDLDIS 82.13 KPA	
		16 NBEALE 0.00589					T03HED***** DEG.C

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 07/26/84 15:50:22.06 RDG 1009

FLUID HELIUM		BAROM 14.303 PSI		REGENERATOR 1	DISPLACER 1	STANDARD PISTON	
HEAT TO DASHPOT COOLING	FLODP 3.97 L/MIN	POWER IN		ENGINE CHARGE PRESSURE		GAS TEMPERATURES	SURFACE TEMPERATURES
		AMPS1 637. AMPS		PRESUP 7339. KPA		TGEXP 561.2 DEG.C	T01HTR 602.1 DEG.C
		AMPS2 585. AMPS				TGREGH 558.9 DEG.C	T02HTR 608.6 DEG.C
TWINDP 17.8 DEG.C		VOLTG 2.66 VOLTS		MEANBP 6999. KPA		TGREGC 94.3 DEG.C	T03HTR 611.2 DEG.C
TDLDP 1.97 DEG.C				MEANCP 7036. KPA		TGCOMP 48.5 DEG.C	T04HTR 60.3 DEG.C
TWODPR 20.5 DEG.C						TGBOUN 32.1 DEG.C	T05HTR 620.1 DEG.C
							T06HTR 611.6 DEG.C
							T07HTR 610.2 DEG.C
							T08HTR 581.4 DEG.C
							T09HTR 609.4 DEG.C
HEAT TO COOLER	FLOCLR 4.23 L/MIN	CALCULATED PARAMETERS		VIBRATION		REMOTE CALCULATIONS	T10HTR 588.8 DEG.C
TWINCL 24.7 DEG.C		1 PWRIN 3253. WATTS		VX1HOR 0.3 CM/S		PWRROUT 794. WATTS	T11HTR 573.6 DEG.C
TDLCL 8.53 DEG.C		2 QCoolR 2505. WATTS		VY1VER 7.9 CM/S		INDPWR 856. WATTS	T12HTR 577.0 DEG.C
TWOCLR 31.51 DEG.C		3 QDShpt 545. WATTS				PISTST 2.40 CM	
		4 EXTEFF 24.4 %		PHASE ANGLES		DISPST 2.22 CM	
		5 TAVHTR 600.3 DEG.C		PADISP 57.1 DEG.			T13REG***** DEG.C
		6 INTEFF 24.1 %		PAPRES -16.5 DEG.			T14REG 517.8 DEG.C
		8 AMPS 1222. AMPS				DYNAMIC CALCULATIONS	T15REG 384.9 DEG.C
		9 QDISPG 3. WATTS		ENGINE SPEED		PAMPC 1063. KPA	T16REG 378.4 DEG.C
		10 QDISP 15. WATTS		FREQ 30.2 Hz		DISPCP 2.37 CM	T17REG 364.0 DEG.C
		11 QREG1 108. WATTS				PISTCP 2.38 CM	T18REG 364.0 DEG.C
		12 QREG2 125. WATTS				PDYNDB***** KPA	T19REG 231.2 DEG.C
		13 QREG3 36. WATTS				PDLCLR 5.43 KPA	
		14 PFP 1012.0 KPA/CM				PDLREG 52.95 KPA	
		15 PFD 324.2 KPA/CM				PDLDIS 90.28 KPA	
		16 NBEALE 0.00609					T03HED***** DEG.C

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 07/26/84 15:55:25.06 RDG 1010

FLUID HELIUM		BAROM 14.303 PSI		REGENERATOR 1	DISPLACER 1	STANDARD PISTON	
HEAT TO DASHPOT COOLING	FLODP 3.96 L/MIN	POWER IN		ENGINE CHARGE PRESSURE		GAS TEMPERATURES	SURFACE TEMPERATURES
		AMPS1 673. AMPS		PRESUP 7464. KPA		TGEXP 557.5 DEG.C	T01HTR 598.1 DEG.C
		AMPS2 619. AMPS				TGREGH 548.5 DEG.C	T02HTR 610.5 DEG.C
TWINDP 17.8 DEG.C		VOLTG 2.82 VOLTS		MEANBP 6988. KPA		TGREGC 90.7 DEG.C	T03HTR 614.9 DEG.C
TDLDP 2.21 DEG.C				MEANCP 7032. KPA		TGCOMP 55.7 DEG.C	T04HTR 601.4 DEG.C
TWODPR 20.8 DEG.C						TGBOUN 33.4 DEG.C	T05HTR 621.1 DEG.C
							T06HTR 613.0 DEG.C
							T07HTR 611.9 DEG.C
							T08HTR 576.7 DEG.C
							T09HTR 605.4 DEG.C
HEAT TO COOLER	FLOCLR 4.22 L/MIN	CALCULATED PARAMETERS		VIBRATION		REMOTE CALCULATIONS	T10HTR 586.4 DEG.C
TWINCL 24.8 DEG.C		1 PWRIN 3643. WATTS		VX1HOR 0.4 CM/S		PWRROUT 866. WATTS	T11HTR 567.1 DEG.C
TDLCL 9.34 DEG.C		2 QCoolR 2736. WATTS		VY1VER 8.5 CM/S		INDPWR 939. WATTS	T12HTR 576.9 DEG.C
TWOCLR 32.52 DEG.C		3 QDShpt 607. WATTS				PISTST 2.60 CM	
		4 EXTEFF 23.8 %		PHASE ANGLES		DISPST 2.34 CM	
		5 TAVHTR 598.6 DEG.C		PADISP 57.5 DEG.			T13REG***** DEG.C
		6 INTEFF 24.0 %		PAPRES -15.7 DEG.			T14REG 510.3 DEG.C
		8 AMPS 1292. AMPS				DYNAMIC CALCULATIONS	T15REG 368.0 DEG.C
		9 QDISPG 3. WATTS		ENGINE SPEED		PAMPC 1147. KPA	T16REG 350.7 DEG.C
		10 QDISP 14. WATTS		FREQ 30.1 Hz		DISPCP 2.37 CM	T17REG 331.5 DEG.C
		11 QREG1 96. WATTS				PISTCP 2.33 CM	T18REG 338.9 DEG.C
		12 QREG2 139. WATTS				PDYNDB***** KPA	T19REG 221.0 DEG.C
		13 QREG3 35. WATTS				PDLCLR 6.79 KPA	
		14 PFP 1002.8 KPA/CM				PDLREG 55.66 KPA	
		15 PFD 314.1 KPA/CM				PDLDIS 95.71 KPA	
		16 NBEALE 0.00617					T03HED***** DEG.C

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TABLE VI. - CONTINUED.

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 07/26/84 16:00:55.09 RDG 1011

FLUID HELIUM		BAROM 14.303 PSI REGENERATOR 1 DISPLACER 1 STANDARD PISTON			
HEAT TO DASHPOT COOLING		POWER IN	ENGINE CHARGE PRESSURE	GAS TEMPERATURES	SURFACE TEMPERATURES
FLODP 3.93 L/MIN		AMPS1 702. AMPS	PRESUP 7063. KPA	TGEXP 555.5 DEG.C	T01HTR 598.9 DEG.C
TWINDP 17.8 DEG.C		AMPS2 653. AMPS	MEANBP 6987. KPA	TGREGH 545.4 DEG.C	T02HTR 612.9 DEG.C
TDLDP 2.67 DEG.C		VOLTG 2.98 VOLTS	MEANCP 7034. KPA	TGREGC 92.1 DEG.C	T03HTR 617.1 DEG.C
TWODPR 21.2 DEG.C				TGCOMP 61.1 DEG.C	T04HTR 602.4 DEG.C
				TGBOUN 35.8 DEG.C	T05HTR 629.1 DEG.C
					T06HTR 616.0 DEG.C
					T07HTR 614.9 DEG.C
					T08HTR 576.4 DEG.C
					T09HTR 606.9 DEG.C
HEAT TO COOLER		CALCULATED PARAMETERS	VIBRATION	REMOTE CALCULATIONS	T10HTR 586.4 DEG.C
FLOCLR 4.23 L/MIN		1 PWRIN 4038. WATTS	VX1HOR 0.4 CM/S	PWRROUT 955. WATTS	T11HTR 566.2 DEG.C
TWINCL 24.9 DEG.C		2 QCoolR 3032. WATTS	VY1VER 9.2 CM/S	INDPWR 1030. WATTS	T12HTR 577.3 DEG.C
TDLCL 10.32 DEG.C		3 QDSHPT 732. WATTS		PISTST 2.80 CM	
TWOCLR 33.65 DEG.C		4 EXTEFF 23.7 %	PHASE ANGLES	DISPST 2.45 CM	
		5 TAVHTR 600.0 DEG.C	PADISP 57.5 DEG.	DYNAMIC CALCULATIONS	T13REG***** DEG.C
		6 INTEFF 24.0 %	PAPRES -15.2 DEG.	PAMPC 1250. KPA	T14REG 506.8 DEG.C
		8 AMPS 1355. AMPS		DISPCP 2.36 CM	T15REG 359.0 DEG.C
		9 QDISPG 3. WATTS	ENGINE SPEED	PISTCP 2.29 CM	T16REG 339.8 DEG.C
		10 QDISP 14. WATTS	FREQ 30.1 HZ	PDYNDB***** KPA	T17REG 317.8 DEG.C
		11 QREG1 90. WATTS		PDLCLR 8.82 KPA	T18REG 326.8 DEG.C
		12 QREG2 146. WATTS		PDLREG 60.41 KPA	T19REG 216.2 DEG.C
		13 QREG3 35. WATTS		PDLDIS103.52 KPA	
		14 PFP 1010.0 KPA/CM			T03HED***** DEG.C
		15 PFD 317.9 KPA/CM			
		16 NBEALE 0.00631			

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 07/26/84 16:03:22.09 RDG 1012

FLUID HELIUM		BAROM 14.303 PSI REGENERATOR 1 DISPLACER 1 STANDARD PISTON			
HEAT TO DASHPOT COOLING		POWER IN	ENGINE CHARGE PRESSURE	GAS TEMPERATURES	SURFACE TEMPERATURES
FLODP 3.93 L/MIN		AMPS1 742. AMPS	PRESUP 7063. KPA	TGEXP 552.5 DEG.C	T01HTR 599.1 DEG.C
TWINDP 17.9 DEG.C		AMPS2 683. AMPS	MEANBP 7000. KPA	TGREGH 540.3 DEG.C	T02HTR 61.6 DEG.C
TDLDP 2.89 DEG.C		VOLTG 3.13 VOLTS	MEANCP 7049. KPA	TGREGC 92.6 DEG.C	T03HTR 617.4 DEG.C
TWODPR 21.4 DEG.C				TGCOMP 65.4 DEG.C	T04HTR 601.2 DEG.C
				TGBOUN 37.2 DEG.C	T05HTR 625.1 DEG.C
					T06HTR 616.7 DEG.C
					T07HTR 615.6 DEG.C
					T08HTR 574.6 DEG.C
HEAT TO COOLER		CALCULATED PARAMETERS	VIBRATION	REMOTE CALCULATIONS	T09HTR 606.0 DEG.C
FLOCLR 4.24 L/MIN		1 PWRIN 4467. WATTS	VX1HOR 0.4 CM/S	PWRROUT 1026. WATTS	T10HTR 585.4 DEG.C
TWINCL 24.9 DEG.C		2 QCoolR 3265. WATTS	VY1VER 9.8 CM/S	INDPWR 1100. WATTS	T11HTR 563.2 DEG.C
TDLCL 11.10 DEG.C		3 QDSHPT 791. WATTS		PISTST 3.00 CM	T12HTR 576.1 DEG.C
TWOCLR 34.54 DEG.C		4 EXTEFF 23.0 %	PHASE ANGLES	DISPST 2.51 CM	
		5 TAVHTR 599.4 DEG.C	PADISP 57.6 DEG.	DYNAMIC CALCULATIONS	T13REG***** DEG.C
		6 INTEFF 23.9 %	PAPRES -14.0 DEG.	PAMPC 1344. KPA	T14REG 500.1 DEG.C
		8 AMPS 1426. AMPS		DISPCP 2.35 CM	T15REG 346.2 DEG.C
		9 QDISPG 3. WATTS	ENGINE SPEED	PISTCP 2.26 CM	T16REG 326.9 DEG.C
		10 QDISP 14. WATTS	FREQ 30.2 HZ	PDYNDB***** KPA	T17REG 303.8 DEG.C
		11 QREG1 85. WATTS		PDLCLR 11.20 KPA	T18REG 313.6 DEG.C
		12 QREG2 151. WATTS		PDLREG 63.81 KPA	T19REG 208.9 DEG.C
		13 QREG3 35. WATTS		PDLDIS109.97 KPA	
		14 PFP 1007.4 KPA/CM			T03HED***** DEG.C
		15 PFD 306.5 KPA/CM			
		16 NBEALE 0.00631			

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 07/26/84 16:30:25.12 RDG 1017

FLUID HELIUM		BAROM 14.298 PSI REGENERATOR 1 DISPLACER 1 STANDARD PISTON			
HEAT TO DASHPOT COOLING		POWER IN	ENGINE CHARGE PRESSURE	GAS TEMPERATURES	SURFACE TEMPERATURES
FLODP 4.08 L/MIN		AMPS1 645. AMPS	PRESUP 7187. KPA	TGEXP 510.7 DEG.C	T01HTR 550.9 DEG.C
TWINDP 18.0 DEG.C		AMPS2 608. AMPS	MEANBP 7011. KPA	TGREGH 507.3 DEG.C	T02HTR 558.5 DEG.C
TDLDP 2.30 DEG.C		VOLTG 2.73 VOLTS	MEANCP 7062. KPA	TGREGC 92.3 DEG.C	T03HTR 565.8 DEG.C
TWODPR 21.0 DEG.C				TGCOMP 53.4 DEG.C	T04HTR 553.1 DEG.C
				TGBOUN 36.2 DEG.C	T05HTR 570.6 DEG.C
					T06HTR 561.8 DEG.C
					T07HTR 560.5 DEG.C
					T08HTR 530.1 DEG.C
					T09HTR 558.1 DEG.C
HEAT TO COOLER		CALCULATED PARAMETERS	VIBRATION	REMOTE CALCULATIONS	T10HTR 537.8 DEG.C
FLOCLR 4.22 L/MIN		1 PWRIN 3424. WATTS	VX1HOR 0.4 CM/S	PWRROUT 776. WATTS	T11HTR 521.5 DEG.C
TWINCL 24.5 DEG.C		2 QCoolR 2713. WATTS	VY1VER 8.5 CM/S	INDPWR 846. WATTS	T12HTR 526.8 DEG.C
TDLCL 9.27 DEG.C		3 QDSHPT 651. WATTS		PISTST 2.60 CM	
TWOCLR 32.09 DEG.C		4 EXTEFF 22.7 %	PHASE ANGLES	DISPST 2.30 CM	
		5 TAVHTR 549.6 DEG.C	PADISP 58.8 DEG.	DYNAMIC CALCULATIONS	T13REG***** DEG.C
		6 INTEFF 22.2 %	PAPRES -14.1 DEG.	PAMPC 1166. KPA	T14REG 473.2 DEG.C
		8 AMPS 1253. AMPS		DISPCP 2.35 CM	T15REG 352.3 DEG.C
		9 QDISPG 3. WATTS	ENGINE SPEED	PISTCP 2.35 CM	T16REG 343.8 DEG.C
		10 QDISP 13. WATTS	FREQ 30.2 HZ	PDYNDB***** KPA	T17REG 330.4 DEG.C
		11 QREG1 93. WATTS		PDLCLR 6.79 KPA	T18REG 330.0 DEG.C
		12 QREG2 116. WATTS		PDLREG 57.70 KPA	T19REG 215.2 DEG.C
		13 QREG3 32. WATTS		PDLDIS 98.77 KPA	
		14 PFP 1003.3 KPA/CM			T03HED***** DEG.C
		15 PFD 289.5 KPA/CM			
		16 NBEALE 0.00549			

TABLE VI. - CONTINUED.

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 07/27/84 10:57:22.54 RDG 1024

FLUID HELIUM		BAROM 14.327 PSI		REGENERATOR 1	DISPLACER 1	STANDARD PISTON	SURFACE TEMPERATURES
HEAT TO DASHPOT COOLING	FLODP 4.47 L/MIN	POWER IN	AMPS1 646. AMPS	ENGINE CHARGE PRESSURE	PRESUP 7572. KPA	GAS TEMPERATURES	T01HTR 501.0 DEG.C
			AMPS2 602. AMPS			TGREXP 462.4 DEG.C	T02HTR 507.9 DEG.C
TWINDP 16.2 DEG.C		VOLTG	2.68 VOLTS	MEANBP	7000. KPA	TGREGH 460.8 DEG.C	T03HTR 515.5 DEG.C
TDLDP 1.71 DEG.C				MEANCP	7048. KPA	TGREGC 90.5 DEG.C	T04HTR 503.0 DEG.C
TWODPR 18.6 DEG.C						TGCOMP 53.8 DEG.C	T05HTR 519.9 DEG.C
						TGBOUN 31.8 DEG.C	T06HTR 511.0 DEG.C
							T07HTR 510.1 DEG.C
							T08HTR 481.0 DEG.C
							T09HTR 507.7 DEG.C
HEAT TO COOLER	FLOCLR 4.21 L/MIN	CALCULATED PARAMETERS		VIBRATION		REMOTE CALCULATIONS	T10HTR 488.1 DEG.C
TWINCL 24.7 DEG.C		1 PWRIN 3348. WATTS		VX1HOR 0.4 CM/S		PWRROUT 707. WATTS	T11HTR 471.9 DEG.C
TDLCL ***** DEG.C		2 QCQLR 2681. WATTS		VY1VER 8.6 CM/S		INDPWR 765. WATTS	T12HTR 476.6 DEG.C
TWOCLR 32.15 DEG.C		3 QDSHPT 531. WATTS				PISTST 2.60 CM	
		4 EXTEFF 21.1 %				DISPST 2.30 CM	
		5 TAVHTR 499.5 DEG.C		PHASE ANGLES		DYNAMIC CALCULATIONS	T13REG***** DEG.C
		6 INTEFF 20.9 %		PADISP 60.4 DEG.		PAMPC 1176. KPA	T14REG 431.6 DEG.C
		8 AMPS 1248. AMPS		PAPRES -12.5 DEG.		DISPPCP 2.32 CM	T15REG 326.4 DEG.C
		9 QDISPG 2. WATTS		ENGINE SPEED		PISTCP 2.28 CM	T16REG 317.8 DEG.C
		10 QDISP 12. WATTS		FREQ 30.2 Hz		PDYNDB***** KPA	T17REG 307.7 DEG.C
		11 QREG1 85. WATTS				PDLCLR 6.96 KPA	T18REG 308.1 DEG.C
		12 QREG2 100. WATTS				PDLREG 58.04 KPA	T19REG 203.0 DEG.C
		13 QREG3 29. WATTS				PDLDIS 99.10 KPA	T03HED***** DEG.C
		14 PFP 995.1 KPA/CM					
		15 PFD 254.7 KPA/CM					
		16 NBEALE 0.00501					

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 07/27/84 11:35:10.54 RDG 1030

FLUID HELIUM		BAROM 14.332 PSI		REGENERATOR 1	DISPLACER 1	STANDARD PISTON	SURFACE TEMPERATURES
HEAT TO DASHPOT COOLING	FLODP 4.11 L/MIN	POWER IN	AMPS1 626. AMPS	ENGINE CHARGE PRESSURE	PRESUP 7562. KPA	GAS TEMPERATURES	T01HTR 452.3 DEG.C
			AMPS2 589. AMPS			TGREXP 415.3 DEG.C	T02HTR 456.8 DEG.C
TWINDP 16.0 DEG.C		VOLTG	2.60 VOLTS	MEANBP	7007. KPA	TGREGH 415.9 DEG.C	T03HTR 465.5 DEG.C
TDLDP 1.90 DEG.C				MEANCP	7061. KPA	TGREGC 88.9 DEG.C	T04HTR 453.6 DEG.C
TWODPR 18.6 DEG.C						TGCOMP 54.6 DEG.C	T05HTR 469.0 DEG.C
						TGBOUN 33.1 DEG.C	T06HTR 459.9 DEG.C
							T07HTR 458.8 DEG.C
							T08HTR 432.9 DEG.C
							T09HTR 458.6 DEG.C
HEAT TO COOLER	FLOCLR 4.21 L/MIN	CALCULATED PARAMETERS		VIBRATION		REMOTE CALCULATIONS	T10HTR 439.4 DEG.C
TWINCL 24.3 DEG.C		1 PWRIN 3159. WATTS		VX1HOR 0.4 CM/S		PWRROUT 605. WATTS	T11HTR 424.0 DEG.C
TDLCL 8.88 DEG.C		2 QCQLR 2595. WATTS		VY1VER 8.6 CM/S		INDPWR 643. WATTS	T12HTR 426.7 DEG.C
TWOCLR 31.77 DEG.C		3 QDSHPT 542. WATTS				PISTST 2.60 CM	
		4 EXTEFF 19.2 %		PHASE ANGLES		DISPST 2.26 CM	
		5 TAVHTR 449.8 DEG.C		PADISP 61.8 DEG.		DYNAMIC CALCULATIONS	T13REG***** DEG.C
		6 INTEFF 18.9 %		PAPRES -10.3 DEG.		PAMPC 1181. KPA	T14REG 389.2 DEG.C
		8 AMPS 1215. AMPS		ENGINE SPEED		DISPPCP 2.30 CM	T15REG 299.6 DEG.C
		9 QDISPG 2. WATTS		FREQ 30.2 Hz		PISTCP 2.25 CM	T16REG 294.9 DEG.C
		10 QDISP 10. WATTS				PDYNDB***** KPA	T17REG 288.2 DEG.C
		11 QREG1 79. WATTS				PDLCLR 6.79 KPA	T18REG 286.8 DEG.C
		12 QREG2 83. WATTS				PDLREG 58.38 KPA	T19REG 190.0 DEG.C
		13 QREG3 25. WATTS				PDLDIS 100.49 KPA	T03HED***** DEG.C
		14 PFP 980.6 KPA/CM					
		15 PFD 212.3 KPA/CM					
		16 NBEALE 0.00428					

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 08/03/84 14:58:23.35 RDG 1070

FLUID HELIUM		BAROM 14.342 PSI		REGENERATOR 1	DISPLACER 1	STANDARD PISTON	SURFACE TEMPERATURES
HEAT TO DASHPOT COOLING	FLODP 4.20 L/MIN	POWER IN	AMPS1 635. AMPS	ENGINE CHARGE PRESSURE	PRESUP 5553. KPA	GAS TEMPERATURES	T01HTR 599.7 DEG.C
			AMPS2 521. AMPS			TGREXP 555.0 DEG.C	T02HTR 606.6 DEG.C
TWINDP 22.4 DEG.C		VOLTG	2.49 VOLTS	MEANBP	5494. KPA	TGREGH 554.7 DEG.C	T03HTR 614.7 DEG.C
TDLDP 1.70 DEG.C				MEANCP	5531. KPA	TGREGC 79.7 DEG.C	T04HTR 601.3 DEG.C
TWODPR 24.7 DEG.C						TGCOMP 49.4 DEG.C	T05HTR 619.1 DEG.C
						TGBOUN 37.7 DEG.C	T06HTR 609.4 DEG.C
							T07HTR 608.6 DEG.C
							T08HTR 580.8 DEG.C
							T09HTR 607.0 DEG.C
HEAT TO COOLER	FLOCLR 4.40 L/MIN	CALCULATED PARAMETERS		VIBRATION		REMOTE CALCULATIONS	T10HTR 586.7 DEG.C
TWINCL 25.2 DEG.C		1 PWRIN 2879. WATTS		VX1HOR 0.3 CM/S		PWRROUT 720. WATTS	T11HTR 573.8 DEG.C
TDLCL 7.00 DEG.C		2 QCQLR 2137. WATTS		VY1VER 7.1 CM/S		INDPWR 759. WATTS	T12HTR 577.7 DEG.C
TWOCLR 30.99 DEG.C		3 QDSHPT 495. WATTS				PISTST 2.61 CM	
		4 EXTEFF 25.0 %		PHASE ANGLES		DISPST 2.46 CM	
		5 TAVHTR 598.8 DEG.C		PADISP 58.7 DEG.		DYNAMIC CALCULATIONS	T13REG***** DEG.C
		6 INTEFF 25.2 %		PAPRES -18.0 DEG.		PAMPC 910. KPA	T14REG 515.2 DEG.C
		8 AMPS 1156. AMPS		ENGINE SPEED		DISPPCP 2.25 CM	T15REG 379.5 DEG.C
		9 QDISPG 3. WATTS		FREQ 26.9 Hz		PISTCP 2.46 CM	T16REG 367.6 DEG.C
		10 QDISP 14. WATTS				PDYNDB***** KPA	T17REG 352.7 DEG.C
		11 QREG1 108. WATTS				PDLCLR 4.41 KPA	T18REG 355.3 DEG.C
		12 QREG2 130. WATTS				PDLREG 42.43 KPA	T19REG 222.0 DEG.C
		13 QREG3 37. WATTS				PDLDIS 71.95 KPA	T03HED***** DEG.C
		14 PFP 795.4 KPA/CM					
		15 PFD 267.8 KPA/CM					
		16 NBEALE 0.00729					

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TABLE VI. - CONTINUED.

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 08/06/84 14:52:24.59 RDG 1079

FLUID HELIUM		BAROM 14.288 PSI REGENERATOR 1 DISPLACER 1 STANDARD PISTON			
HEAT TO DASHPOT COOLING	FLODP 4.08 L/MIN	POWER IN	ENGINE CHARGE PRESSURE	GAS TEMPERATURES	SURFACE TEMPERATURES
		AMPS1 539. AMPS	PRESUP 4143. KPA	TGEXP 553.1 DEG.C	T01HTR 605.6 DEG.C
		AMPS2 451. AMPS			T02HTR 599.1 DEG.C
TWINDP 23.0 DEG.C	VOLTG 2.13 VOLTS		MEANBP 3988. KPA	TGREGH 560.1 DEG.C	T03HTR 614.7 DEG.C
TDLDP 0.81 DEG.C			MEANCP 4012. KPA	TGREGC 70.5 DEG.C	T04HTR 603.7 DEG.C
TWODPR 24.4 DEG.C				TGCOMP 41.6 DEG.C	T05HTR 615.3 DEG.C
				TGBOUN 32.0 DEG.C	T06HTR 600.7 DEG.C
					T07HTR 601.4 DEG.C
					T08HTR 589.7 DEG.C
					T09HTR 607.8 DEG.C
HEAT TO COOLER	FLOCLR 4.31 L/MIN	CALCULATED PARAMETERS	VIBRATION	REMOTE CALCULATIONS	T10HTR 591.6 DEG.C
		1 PWRIN 2109. WATTS	VX1HOR 0.2 CM/S	PWRROUT 500. WATTS	T11HTR 581.8 DEG.C
		2 QCOOLR 1242. WATTS	VY1VER 5.8 CM/S	INDPWR 520. WATTS	T12HTR 581.3 DEG.C
TWINCL 25.2 DEG.C		3 QDSHPT 228. WATTS		PISTST 2.61 CM	
TDLCL 4.15 DEG.C		4 EXTEFF 23.7 %	PHASE ANGLES	DISPST 2.55 CM	
TWOCLR 29.17 DEG.C		5 TAVHTR 599.4 DEG.C	PADISP 58.4 DEG.		T13REG***** DEG.C
		6 INTEFF 28.7 %	PAPRES -19.7 DEG.		T14REG 512.2 DEG.C
		8 AMPS 990. AMPS		DYNAMIC CALCULATIONS	T15REG 376.1 DEG.C
		9 QDISPG 3. WATTS		PAMPC 645. KPA	
		10 QDISP 15. WATTS	ENGINE SPEED	DISPCP 2.18 CM	T16REG 367.6 DEG.C
		11 QREG1 121. WATTS	FREQ 23.0 HZ	PISTCP 2.40 CM	T17REG 363.5 DEG.C
		12 QREG2 121. WATTS		PDYNDB***** KPA	T18REG 363.0 DEG.C
		13 QREG3 38. WATTS		PDLCLR 2.72 KPA	T19REG 213.7 DEG.C
		14 PFP 568.8 KPA/CM		PDLREG 29.53 KPA	
		15 PFD 200.5 KPA/CM		PDLDIS 49.21 KPA	T03HED***** DEG.C
		16 NBEALE 0.00815			

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 08/08/84 13:36:21.40 RDG 1121

FLUID HELIUM		BAROM 14.234 PSI REGENERATOR 1 DISPLACER 1 STANDARD PISTON			
HEAT TO DASHPOT COOLING	FLODP 4.37 L/MIN	POWER IN	ENGINE CHARGE PRESSURE	GAS TEMPERATURES	SURFACE TEMPERATURES
		AMPS1 702. AMPS	PRESUP 7093. KPA	TGEXP 557.0 DEG.C	T01HTR 602.6 DEG.C
		AMPS2 595. AMPS			T02HTR 604.7 DEG.C
TWINDP 25.4 DEG.C	VOLTG 2.78 VOLTS		MEANBP 7012. KPA	TGREGH 559.4 DEG.C	T03HTR 616.7 DEG.C
TDLDP 2.18 DEG.C			MEANCP 7066. KPA	TGREGC 109.0 DEG.C	T04HTR 603.0 DEG.C
TWODPR 28.0 DEG.C				TGCOMP 64.0 DEG.C	T05HTR 621.4 DEG.C
				TGBOUN 44.0 DEG.C	T06HTR 609.5 DEG.C
					T07HTR 608.0 DEG.C
					T08HTR 580.9 DEG.C
					T09HTR 611.3 DEG.C
HEAT TO COOLER	FLOCLR 4.36 L/MIN	CALCULATED PARAMETERS	VIBRATION	REMOTE CALCULATIONS	T10HTR 586.0 DEG.C
		1 PWRIN 3599. WATTS	VX1HOR 0.4 CM/S	PWRROUT 845. WATTS	T11HTR 574.7 DEG.C
		2 QCOOLR 2532. WATTS	VY1VER 8.6 CM/S	INDPWR 907. WATTS	T12HTR 574.8 DEG.C
TWINCL 39.9 DEG.C		3 QDSHPT 662. WATTS		PISTST 2.61 CM	
TDLCL 8.42 DEG.C		4 EXTEFF 23.5 %	PHASE ANGLES	DISPST 2.35 CM	
TWOCLR 46.99 DEG.C		5 TAVHTR 599.5 DEG.C	PADISP 58.5 DEG.		T13REG***** DEG.C
		6 INTEFF 25.0 %	PAPRES -14.9 DEG.		T14REG 519.6 DEG.C
		8 AMPS 1296. AMPS		DYNAMIC CALCULATIONS	T15REG 391.9 DEG.C
		9 QDISPG 3. WATTS	ENGINE SPEED	PAMPC 1171. KPA	
		10 QDISP 14. WATTS	FREQ 30.3 HZ	DISPCP 2.29 CM	T16REG 391.7 DEG.C
		11 QREG1 111. WATTS		PISTCP 2.34 CM	T17REG 386.0 DEG.C
		12 QREG2 114. WATTS		PDYNDB***** KPA	T18REG 378.7 DEG.C
		13 QREG3 35. WATTS		PDLCLR 6.11 KPA	T19REG 241.7 DEG.C
		14 PFP 1007.1 KPA/CM		PDLREG 56.34 KPA	
		15 PFD 300.9 KPA/CM		PDLDIS 96.73 KPA	T03HED***** DEG.C
		16 NBEALE 0.00593			

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 08/27/84 14:05:40.27 RDG 1200

FLUID HELIUM		BAROM 14.332 PSI REGENERATOR 1 DISPLACER 1 STANDARD PISTON			
HEAT TO DASHPOT COOLING	FLODP 4.01 L/MIN	POWER IN	ENGINE CHARGE PRESSURE	GAS TEMPERATURES	SURFACE TEMPERATURES
		AMPS1 694. AMPS	PRESUP 7311. KPA	TGEXP 558.0 DEG.C	T01HTR 600.3 DEG.C
		AMPS2 569. AMPS			T02HTR 607.1 DEG.C
TWINDP 18.7 DEG.C	VOLTG 2.77 VOLTS		MEANBP 6986. KPA	TGREGH 558.6 DEG.C	T03HTR 614.6 DEG.C
TDLDP 2.63 DEG.C			MEANCP 7031. KPA	TGREGC 123.0 DEG.C	T04HTR 605.0 DEG.C
TWODPR 22.1 DEG.C				TGCOMP 74.7 DEG.C	T05HTR 619.5 DEG.C
				TGBOUN 43.1 DEG.C	T06HTR 611.7 DEG.C
					T07HTR 610.3 DEG.C
					T08HTR 578.4 DEG.C
					T09HTR 612.6 DEG.C
HEAT TO COOLER	FLOCLR 4.15 L/MIN	CALCULATED PARAMETERS	VIBRATION	REMOTE CALCULATIONS	T10HTR 584.7 DEG.C
		1 PWRIN 3493. WATTS	VX1HOR 0.6 CM/S	PWRROUT 777. WATTS	T11HTR 575.1 DEG.C
		2 QCOOLR 2108. WATTS	VY1VER 8.4 CM/S	INDPWR 837. WATTS	T12HTR 575.6 DEG.C
TWINCL 54.0 DEG.C		3 QDSHPT 734. WATTS		PISTST 2.60 CM	
TDLCL 7.39 DEG.C		4 EXTEFF 22.2 %	PHASE ANGLES	DISPST 2.29 CM	
TWOCLR 60.48 DEG.C		5 TAVHTR 599.6 DEG.C	PADISP 59.1 DEG.		T13REG***** DEG.C
		6 INTEFF 26.9 %	PAPRES -13.7 DEG.		T14REG 522.7 DEG.C
		8 AMPS 1263. AMPS		DYNAMIC CALCULATIONS	T15REG 402.6 DEG.C
		9 QDISPG 3. WATTS	ENGINE SPEED	PAMPC 1161. KPA	
		10 QDISP 14. WATTS	FREQ 30.2 HZ	DISPCP 2.25 CM	T16REG 402.4 DEG.C
		11 QREG1 103. WATTS		PISTCP 2.34 CM	T17REG 388.9 DEG.C
		12 QREG2 114. WATTS		PDYNDB***** KPA	T18REG 382.4 DEG.C
		13 QREG3 34. WATTS		PDLCLR 6.11 KPA	T19REG 255.2 DEG.C
		14 PFP 994.2 KPA/CM		PDLREG 53.29 KPA	
		15 PFD 280.7 KPA/CM		PDLDIS 91.98 KPA	T03HED***** DEG.C
		16 NBEALE 0.00551			

TABLE VI. - CONCLUDED.

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 09/26/84 10:54:20.52 RDG 1357

FLUID HELIUM		BAROM 14.474 PSI REGENERATOR 1 DISPLACER 2 STANDARD PISTON				SURFACE TEMPERATURES	
HEAT TO DASHPOT COOLING	FLODP 4.38 L/MIN	POWER IN	ENGINE CHARGE PRESSURE	GAS TEMPERATURES	TGEXP 559.5 DEG.C	T01HTR 601.7 DEG.C	
		AMPS1 680. AMPS	PRESUP 7163. KPA	TGEGH 551.9 DEG.C	T02HTR 614.3 DEG.C		
		AMPS2 605. AMPS	MEANBP 6992. KPA	TGREGC 98.6 DEG.C	T03HTR 612.7 DEG.C		
TWINDP 18.8 DEG.C	VOLTG 2.78 VOLTS		MEANCP 7033. KPA	TGCOMP 51.6 DEG.C	T04HTR 608.1 DEG.C		
TDLDP 1.99 DEG.C				TGBOUN 35.8 DEG.C	T05HTR 618.4 DEG.C		
TWODPR 21.4 DEG.C					T06HTR 611.3 DEG.C		
					T07HTR 610.5 DEG.C		
					T08HTR 578.3 DEG.C		
					T09HTR 610.9 DEG.C		
HEAT TO COOLER	CALCULATED PARAMETERS	VIBRATION	REMOTE CALCULATIONS	T10HTR 589.1 DEG.C			
FLOCRL 4.22 L/MIN	1 PWRIN 3575. WATTS	VX1HOR 0.7 CM/S	FNROUT 798. WATTS	T11HTR 573.5 DEG.C			
TWINCL 25.0 DEG.C	2 QCOOLR 2563. WATTS	VY1VER 8.9 CM/S	INDPWR 818. WATTS	T12HTR 582.0 DEG.C			
TDLCL 8.75 DEG.C	3 QDSHPT 605. WATTS		PISTST 2.61 CM				
TWOCLR 32.75 DEG.C	4 EXTEFF 22.3 %	PHASE ANGLES	DISPST 1.88 CM				
	5 TAVHTR 600.9 DEG.C	PADISP 77.7 DEG.	DYNAMIC CALCULATIONS	T13REG***** DEG.C			
	6 INTEFF 23.7 %	PAPRES -11.3 DEG.	PAMPC 1299. KPA	T14REG 514.2 DEG.C			
	8 AMPS 1285. AMPS		DISPCP 2.65 CM	T15REG 390.1 DEG.C			
	9 QDISPG 3. WATTS	ENGINE SPEED	PISTCP 2.36 CM	T16REG 386.3 DEG.C			
	10 QDISP 14. WATTS	FREQ 31.3 HZ	PDYNDB 1163. KPA	T17REG 378.5 DEG.C			
	11 QREG1 103. WATTS		PDLCLR 7.81 KPA	T18REG 364.0 DEG.C			
	12 QREG2 122. WATTS		PDLREG 57.36 KPA	T19REG 237.4 DEG.C			
	13 QREG3 35. WATTS		PDLDIS 99.10 KPA	T03HED***** DEG.C			
	14 PFP 1020.3 KPA/CM						
	15 PFD 277.8 KPA/CM						
	16 NBEALE 0.00545						

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 11/27/84 10:56:18.08 RDG 1552

FLUID NITROGEN		BAROM 14.357 PSI REGENERATOR 1 DISPLACER 1 STANDARD PISTON				SURFACE TEMPERATURES	
HEAT TO DASHPOT COOLING	FLODP 4.00 L/MIN	POWER IN	ENGINE CHARGE PRESSURE	GAS TEMPERATURES	TGEXP 566.9 DEG.C	T01HTR 602.2 DEG.C	
		AMPS1 565. AMPS	PRESUP 7160. KPA	TGEGH 552.1 DEG.C	T02HTR 615.1 DEG.C		
		AMPS2 437. AMPS	MEANBP 7010. KPA	TGREGC 109.5 DEG.C	T03HTR 604.1 DEG.C		
TWINDP 19.2 DEG.C	VOLTG 2.20 VOLTS		MEANCP 7058. KPA	TGCOMP 40.9 DEG.C	T04HTR 616.8 DEG.C		
TDLDP 1.10 DEG.C				TGBOUN 27.3 DEG.C	T05HTR 602.7 DEG.C		
TWODPR 20.4 DEG.C					T06HTR 604.2 DEG.C		
					T07HTR 603.7 DEG.C		
					T08HTR 584.2 DEG.C		
					T09HTR 607.4 DEG.C		
HEAT TO COOLER	CALCULATED PARAMETERS	VIBRATION	REMOTE CALCULATIONS	T10HTR 596.9 DEG.C			
FLOCRL 4.35 L/MIN	1 PWRIN 2210. WATTS	VX1HOR 0.6 CM/S	PWRROUT 292. WATTS	T11HTR 579.0 DEG.C			
TWINCL 25.2 DEG.C	2 QCOOLR 1948. WATTS	VY1VER 7.5 CM/S	INDPWR 314. WATTS	T12HTR 583.9 DEG.C			
TDLCL 6.46 DEG.C	3 QDSHPT 306. WATTS		PISTST 2.56 CM				
TWOCLR 29.99 DEG.C	4 EXTEFF 13.2 %	PHASE ANGLES	DISPST 1.56 CM				
	5 TAVHTR 600.0 DEG.C	PADISP 36.5 DEG.	DYNAMIC CALCULATIONS	T13REG***** DEG.C			
	6 INTEFF 13.0 %	PAPRES -5.5 DEG.	PAMPC 1102. KPA	T14REG 497.4 DEG.C			
	8 AMPS 1002. AMPS		DISPCP 2.47 CM	T15REG 385.4 DEG.C			
	9 QDISPG 0. WATTS	ENGINE SPEED	PISTCP 2.41 CM	T16REG 391.0 DEG.C			
	10 QDISP 15. WATTS	FREQ 28.0 HZ	PDYNDB***** KPA	T17REG 391.1 DEG.C			
	11 QREG1 112. WATTS		PDLCLR 14.93 KPA	T18REG 375.3 DEG.C			
	12 QREG2 99. WATTS		PDLREG 61.09 KPA	T19REG 236.7 DEG.C			
	13 QREG3 34. WATTS		PDLDIS 154.77 KPA	T03HED***** DEG.C			
	14 PFP 967.5 KPA/CM						
	15 PFD 226.5 KPA/CM						
	16 NBEALE 0.00226						

NASA LEWIS SENSITIVITY TEST DATA RE 1000 FREE PISTON STIRLING ENGINE TEST D003, REC 12/07/84 14:42:20.19 RDG 1608

FLUID HELIUM		BAROM 14.322 PSI REGENERATOR 1 DISPLACER 1 LIGHT PISTON				SURFACE TEMPERATURES	
HEAT TO DASHPOT COOLING	FLODP 4.12 L/MIN	POWER IN	ENGINE CHARGE PRESSURE	GAS TEMPERATURES	TGEXP 558.4 DEG.C	T01HTR 606.1 DEG.C	
		AMPS1 653. AMPS	PRESUP 7070. KPA	TGEGH 566.1 DEG.C	T02HTR 606.3 DEG.C		
		AMPS2 517. AMPS	MEANBP 7016. KPA	TGREGC 102.3 DEG.C	T03HTR 614.3 DEG.C		
TWINDP 18.0 DEG.C	VOLTG 2.58 VOLTS		MEANCP 7063. KPA	TGCOMP 46.1 DEG.C	T04HTR 606.5 DEG.C		
TDLDP 2.44 DEG.C				TGBOUN 32.6 DEG.C	T05HTR 617.5 DEG.C		
TWODPR 20.5 DEG.C					T06HTR 611.5 DEG.C		
					T07HTR 610.5 DEG.C		
					T08HTR 584.0 DEG.C		
					T09HTR 615.3 DEG.C		
HEAT TO COOLER	CALCULATED PARAMETERS	VIBRATION	REMOTE CALCULATIONS	T10HTR 582.2 DEG.C			
FLOCRL 4.26 L/MIN	1 PWRIN 3018. WATTS	VX1HOR 0.4 CM/S	PWRROUT 572. WATTS	T11HTR 581.7 DEG.C			
TWINCL 25.3 DEG.C	2 QCOOLR 2618. WATTS	VY1VER 6.0 CM/S	INDPWR 511. WATTS	T12HTR 573.3 DEG.C			
TDLCL 8.86 DEG.C	3 QDSHPT 701. WATTS		PISTST 2.56 CM				
TWOCLR 31.88 DEG.C	4 EXTEFF 19.0 %	PHASE ANGLES	DISPST 1.90 CM				
	5 TAVHTR 600.8 DEG.C	PADISP 41.6 DEG.	DYNAMIC CALCULATIONS	T13REG***** DEG.C			
	6 INTEFF 17.9 %	PAPRES -8.1 DEG.	PAMPC 1102. KPA	T14REG 522.1 DEG.C			
	8 AMPS 1170. AMPS		DISPCP 2.28 CM	T15REG 398.0 DEG.C			
	9 QDISPG 3. WATTS	ENGINE SPEED	PISTCP 2.37 CM	T16REG 402.5 DEG.C			
	10 QDISP 15. WATTS	FREQ 37.4 HZ	PDYNDB***** KPA	T17REG 402.6 DEG.C			
	11 QREG1 119. WATTS		PDLCLR 4.41 KPA	T18REG 390.7 DEG.C			
	12 QREG2 107. WATTS		PDLREG 40.05 KPA	T19REG 243.5 DEG.C			
	13 QREG3 36. WATTS		PDLDIS 75.69 KPA	T03HED***** DEG.C			
	14 PFP 987.2 KPA/CM						
	15 PFD 245.5 KPA/CM						
	16 NBEALE 0.00331						

TABLE VII. - LIST OF SINGLE VARIABLE DATA POINTS

[Regenerator and displacer 1 were designed for high efficiency. Regenerator and displacer 2 were designed for high power.]

Nominal Values								
Reading Number	Gas	Heater, °C	Cooler, °C	Pressure, MPa	Stroke, cm	Disp.	Regen.	Pist.
1006-1012	He	600	25	7.0	Var 1.8, 2.0, ...	1	1	Std
1010, 1070, 1079	He	600	25	Var 7.0, 5.5, 4.0	2.6	1	1	Std
1010, 1017, 1024, 1030	He	Var 600, 550 500, 450	25	7.0	2.6	1	1	Std
1010, 1121, 1200	He	600	Var 25, 40, 55	7.0	2.6	1	1	Std
1010, 1357	He	600	25	7.0	2.6	Var 1, 2	1	Std
1010, 602	He	600	25	7.0	2.6	1	Var 1, 2	Std
1010, 1608	He	600	25	7.0	2.6	1	1	Var Std and Light
1010, 1552	Var He, N ₂	600	25	7.0	2.6	1	1	Std

TABLE VIII. - LIST OF DOUBLE VARIABLE DATA POINTS

SVDS reading numbers	DVDS reading numbers (stroke varied starting at 1.8 cm)	
602	598-602	(1.8-2.6 cm)
1006	1006-1012	(1.8-3.0 cm)
1007		
1008		
1009		
1010		
1011		
1012		
1017	1013-1019	
1024	1020-1025	(1.8-2.8 cm)
1030	1026-1032	(1.8-3.0 cm)
1070	1066-1072	
1079	1075-1081	
1121	1117-1122	(1.8-2.8 cm)
1200	1196-1202	(1.8-3.0 cm)
1357	1353-1360	(1.8-3.2 cm)
1552	1548-1552	(1.8-2.6 cm)
1608	1604-1610	(1.8-3.0 cm)

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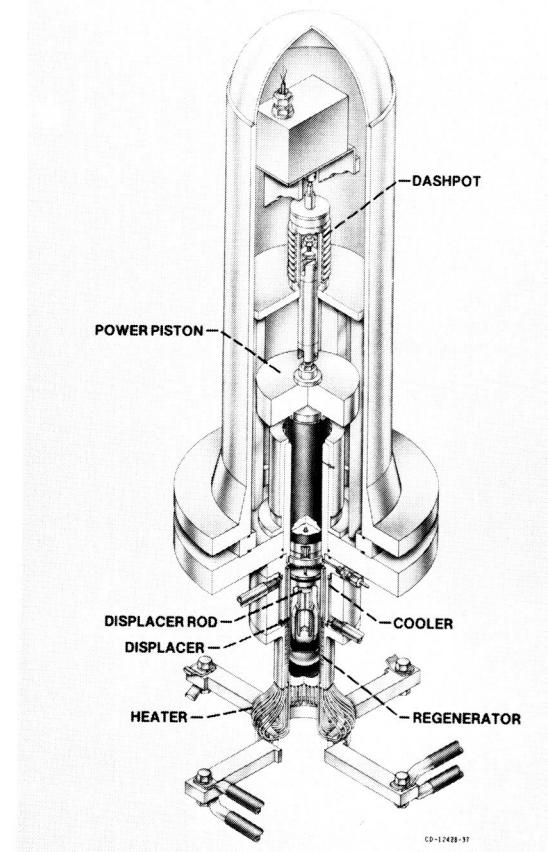


FIGURE 1. - COMPONENT LAYOUT OF RE-1000 FREE PISTON STIRLING ENGINE.

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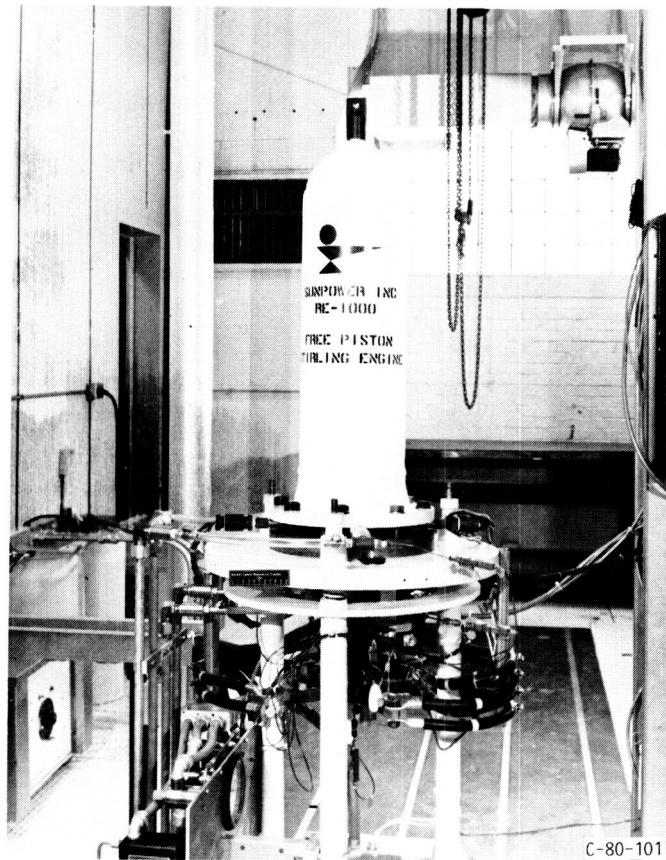


FIGURE 2. - RE-1000 FREE-PISTON STRILING ENGINE IN TEST CELL.

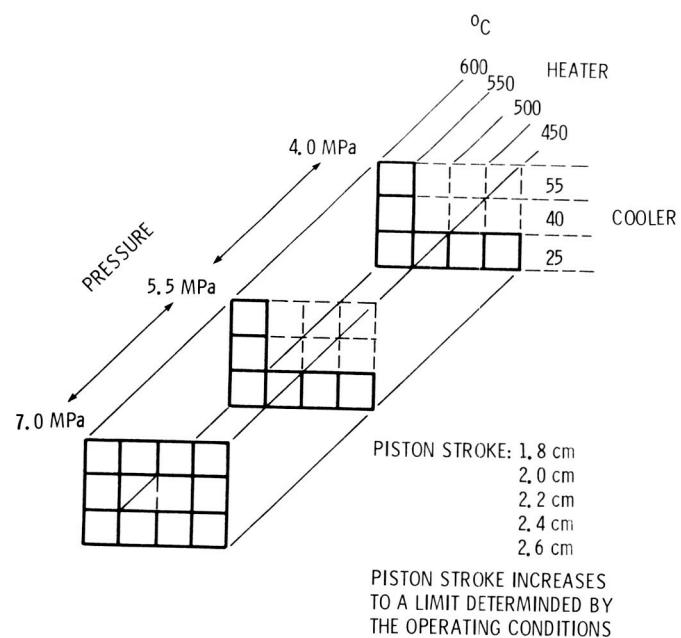


FIGURE 3.- RE-1000 TEST MATRIX.

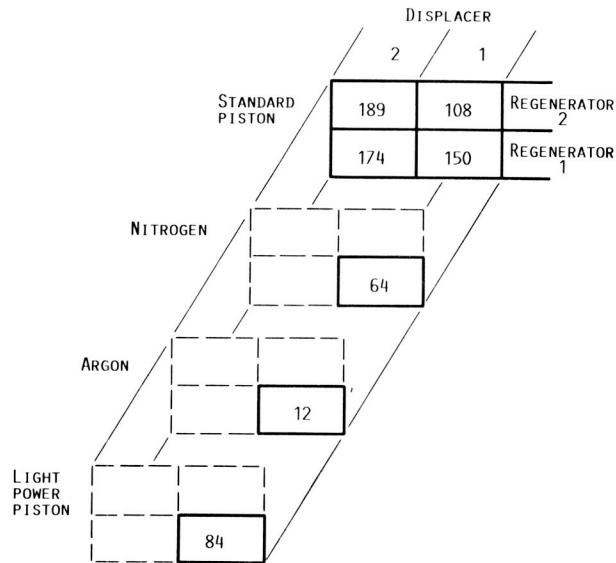


FIGURE 4.- CONFIGURATION MATRIX WITH NUMBER OF READINGS.

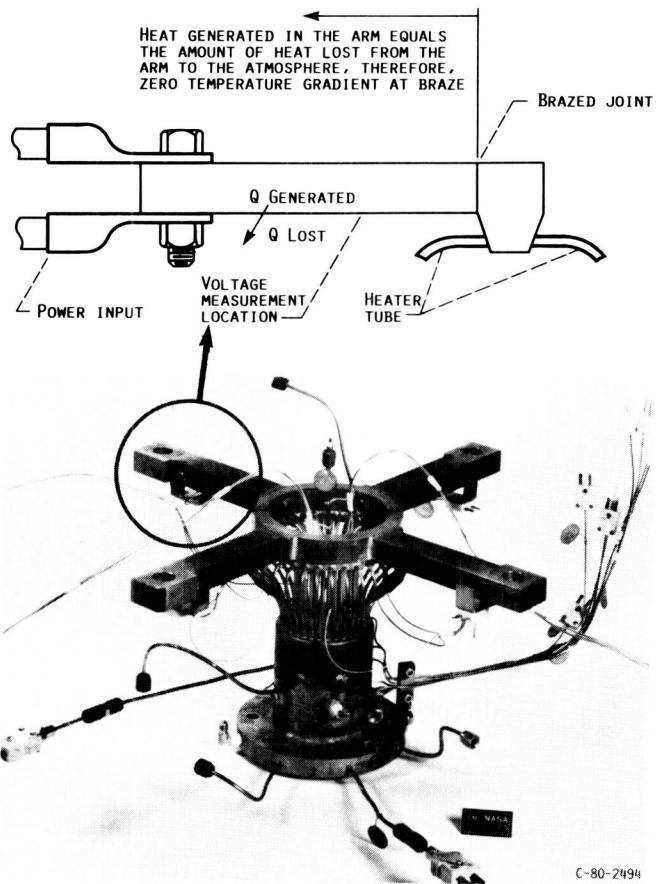


FIGURE 5.- RE-1000 HEATER HEAD.

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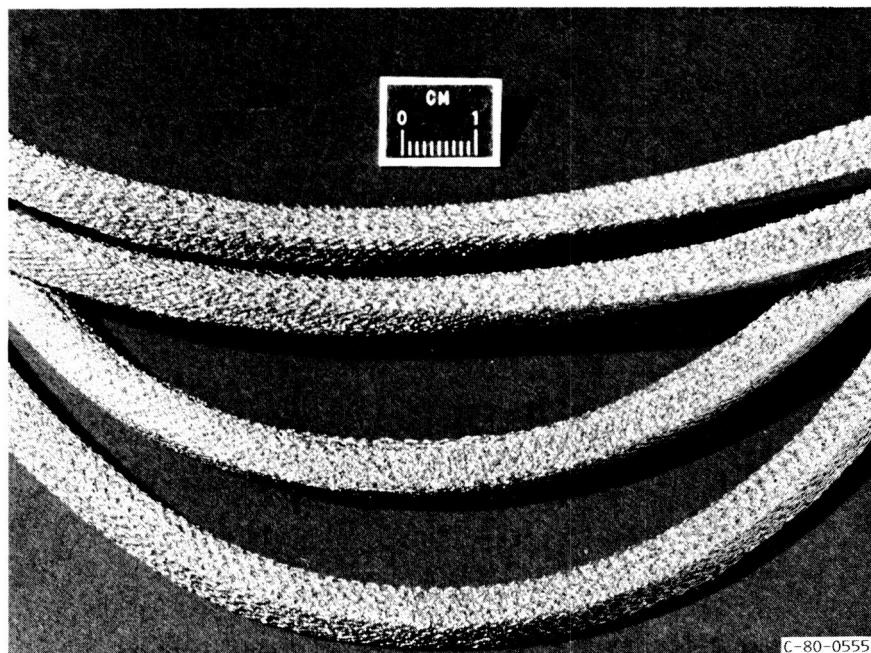


FIGURE 6. - METEX KNITTED REGENERATOR MATRIX.

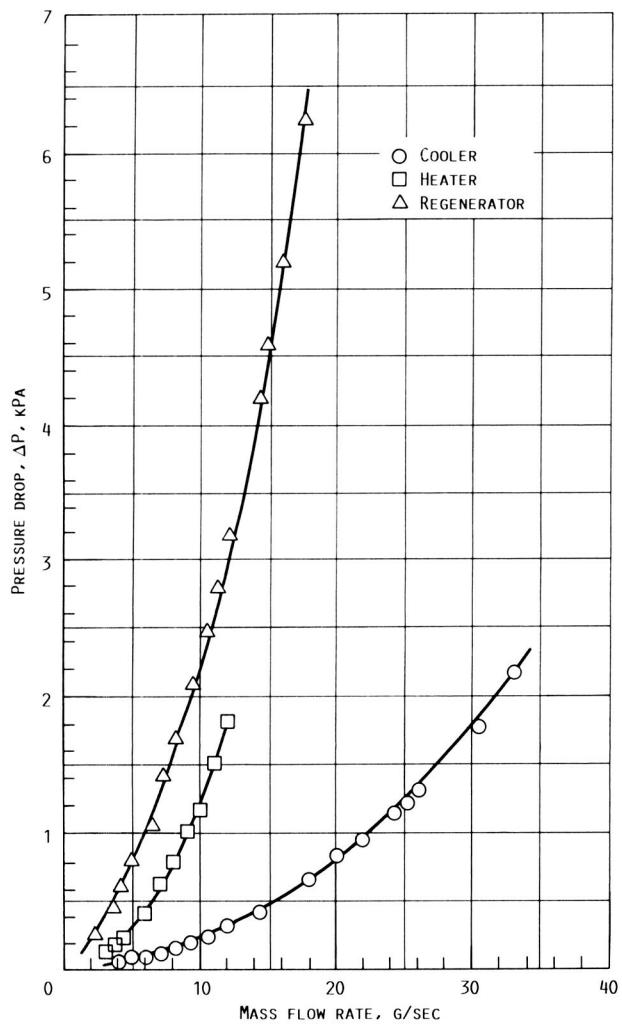


FIGURE 7.- PRESSURE DROP AS A FUNCTION OF MASS FLOW RATE
WITH REGENERATOR 1. TESTED WITH NITROGEN AT 2070 KPA FOR
THE COOLER AND REGENERATOR, AND 1380 KPA FOR THE HEATER.
NITROGEN TEMPERATURE WAS 15 OC.

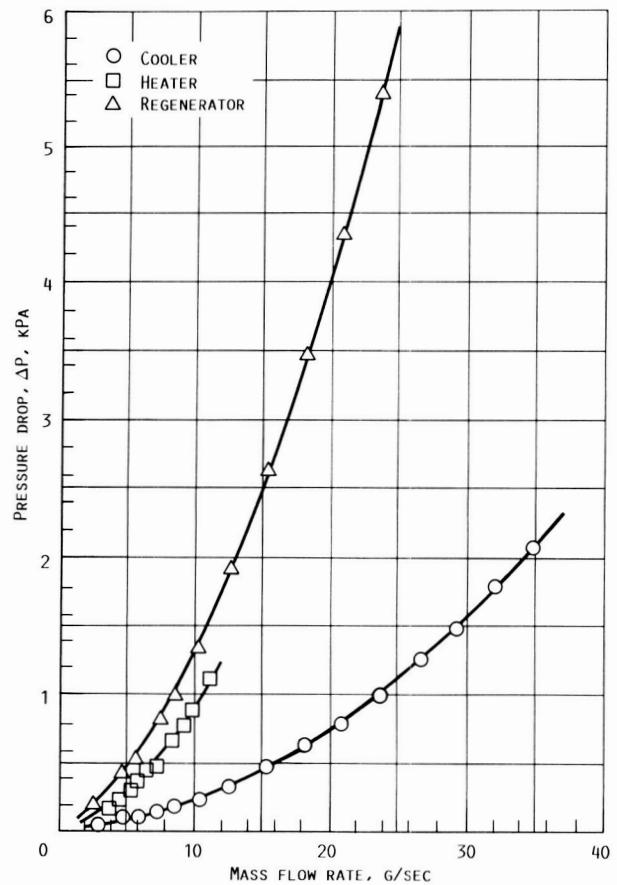
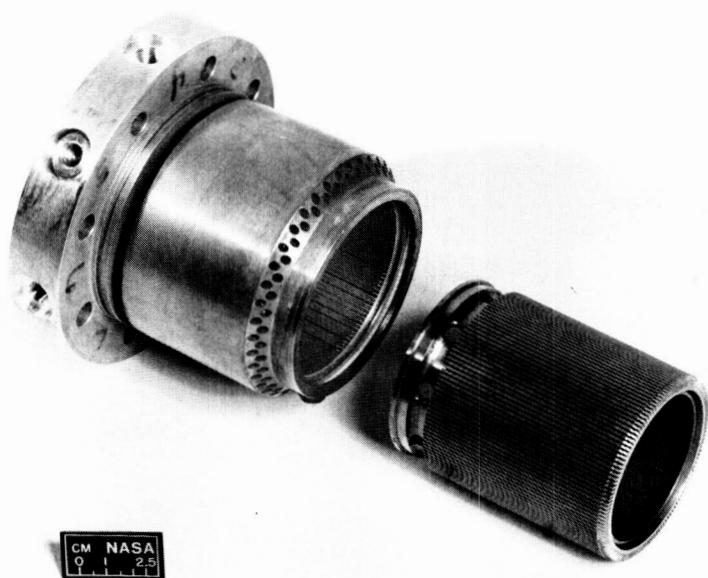


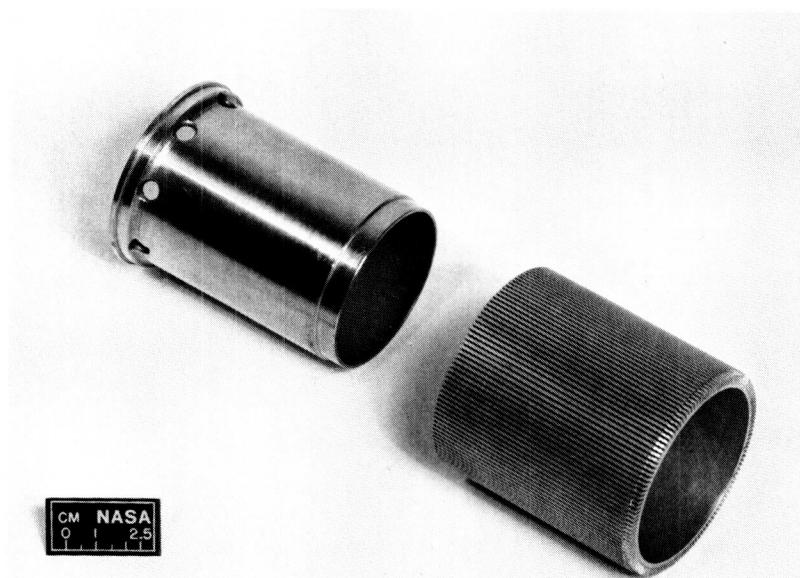
FIGURE 8. - PRESSURE DROP AS A FUNCTION OF MASS FLOW RATE WITH REGENERATOR 2. TESTED WITH NITROGEN AT 2070 KPA FOR THE COOLER AND REGENERATOR, AND 1380 KPA FOR THE HEATER. NITROGEN TEMPERATURE WAS 10 OC.



C-80-2471

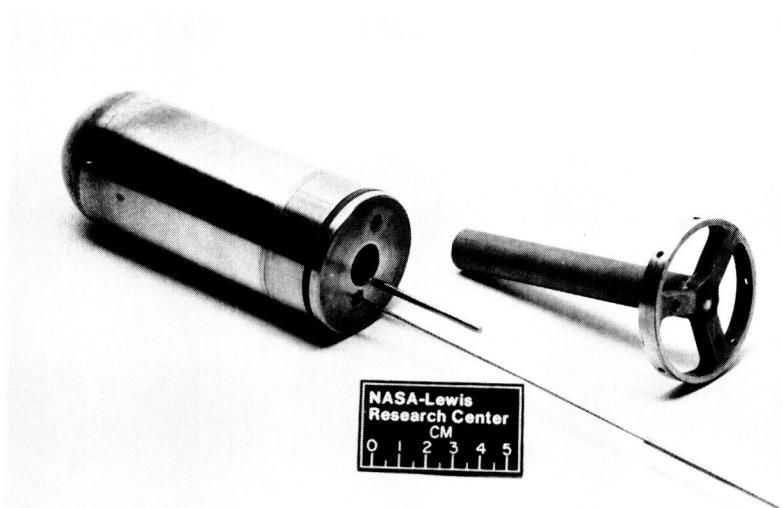
FIGURE 9. - RE-1000 COOLER AND HOUSING.

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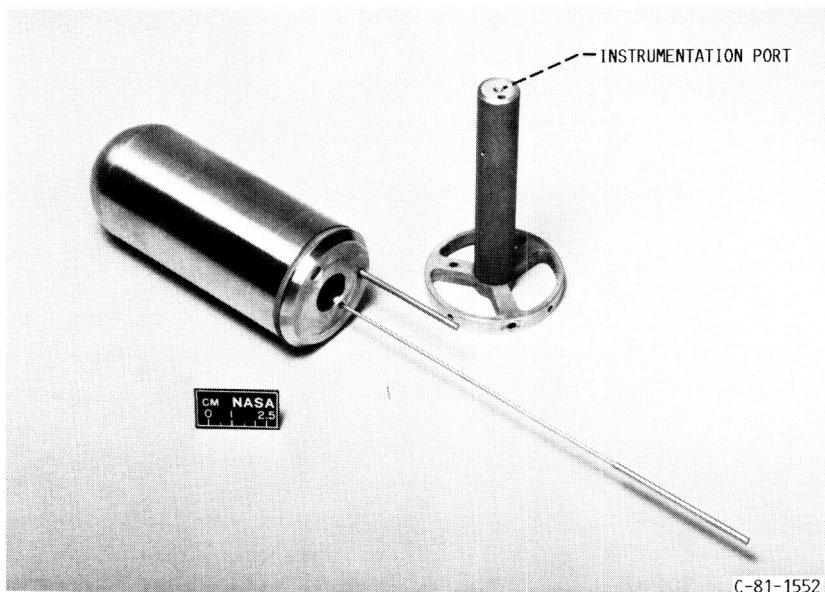
C-80-2472

FIGURE 10. - DISPLACER CYLINDER AND COOLER GAS PASSAGES.



C-79-4607

FIGURE 11. - DISPLACER AND DISPLACER ROD 1.



C-81-1552

FIGURE 12. - DISPLACER AND DISPLACER ROD 2.

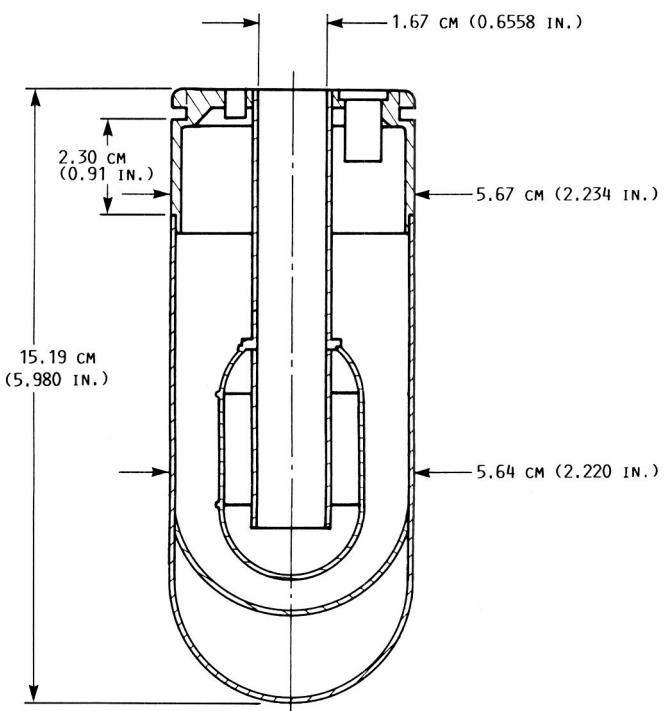


FIGURE 13.- DISPLACER 1 CROSS-SECTION. DISPLACER WEIGHT, 426 G (0.94 LB); GAS SPRING MEAN VOLUME, 31.79 CM³ (1.94 IN.³).

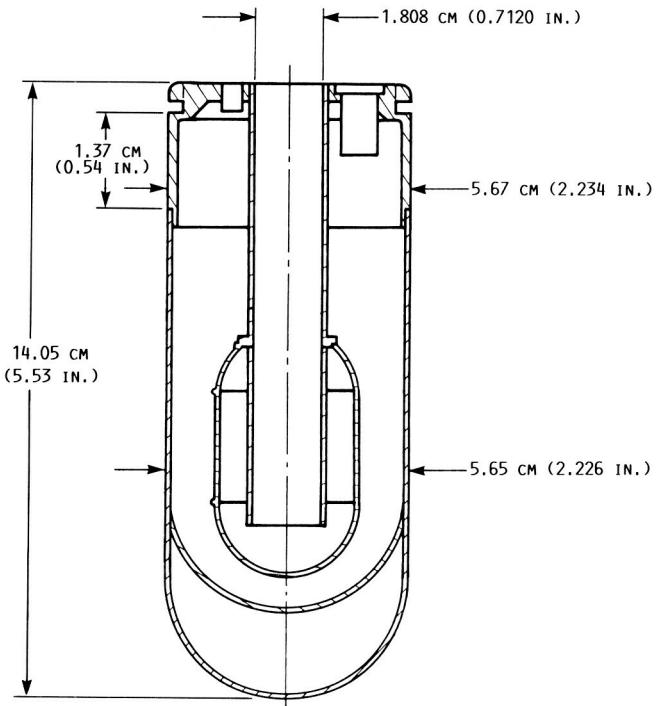
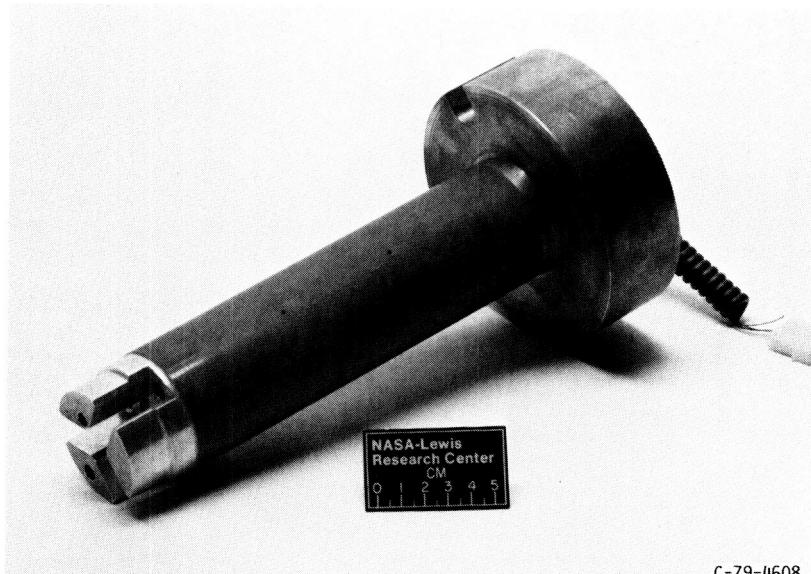
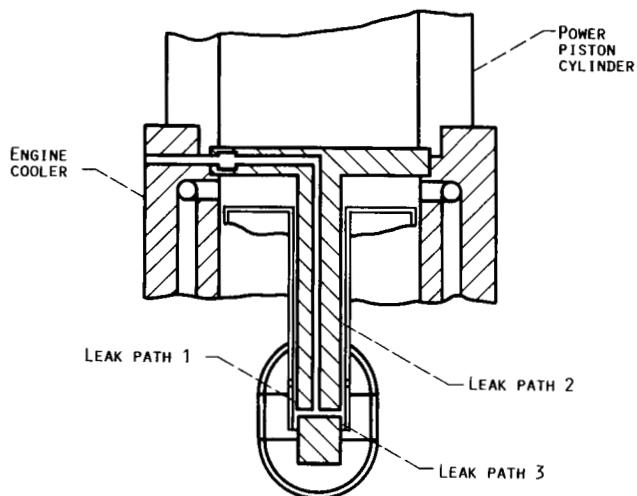


FIGURE 14.- DISPLACER 2 CROSS-SECTION. DISPLACER WEIGHT 381.36 (0.84 LB), GAS SPRING MEAN VOLUME, 18.80 CM³(1.147 IN.³).

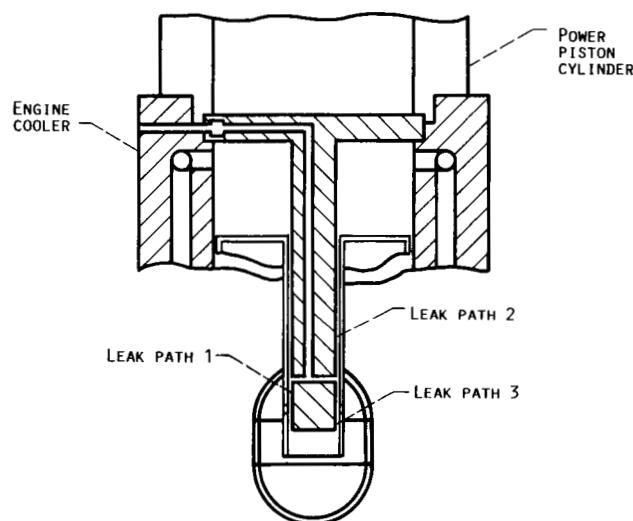


C-79-4608

FIGURE 15. - RE-1000 FREE-PISTON STRILING ENGINE POWER PISTON.



(A) WHEN DISPLACER IS AT COMPRESSION SPACE.



(B) WHEN DISPLACER IS AT EXPANSION SPACE.

FIGURE 16. - DISPLACER ROD MOUNTING WITH CENTER PORTS AND LEAK PATHS SHOW.

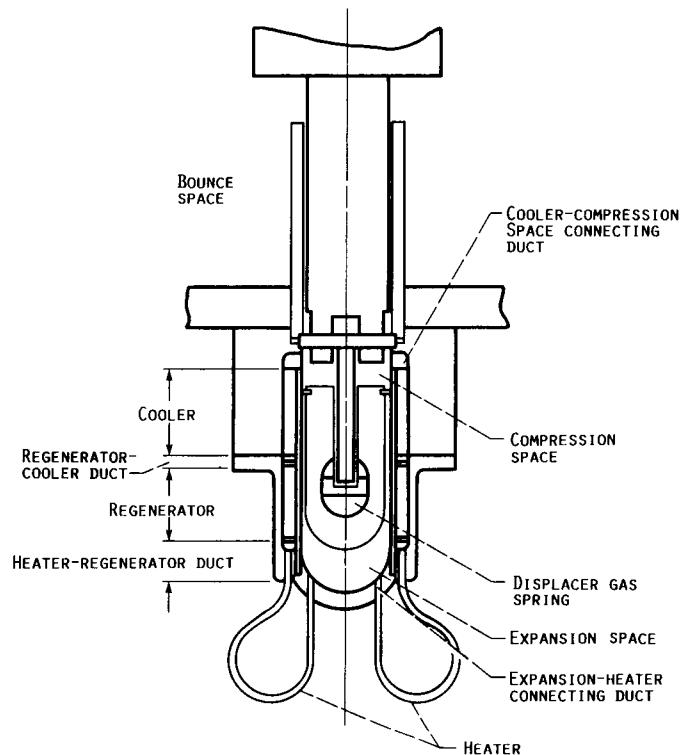


FIGURE 17.- DEFINITIONS OF VOLUMES IN THE ENGINE.

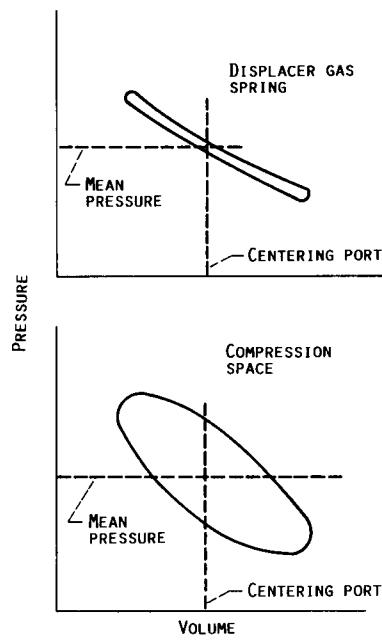
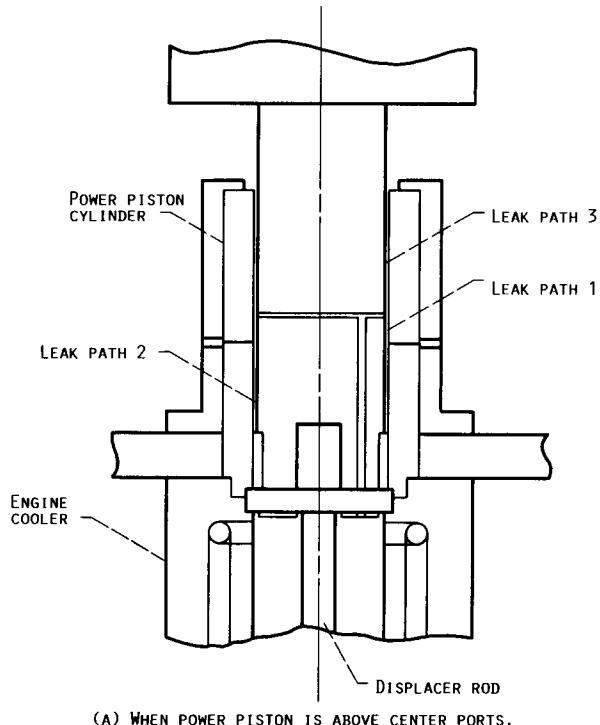
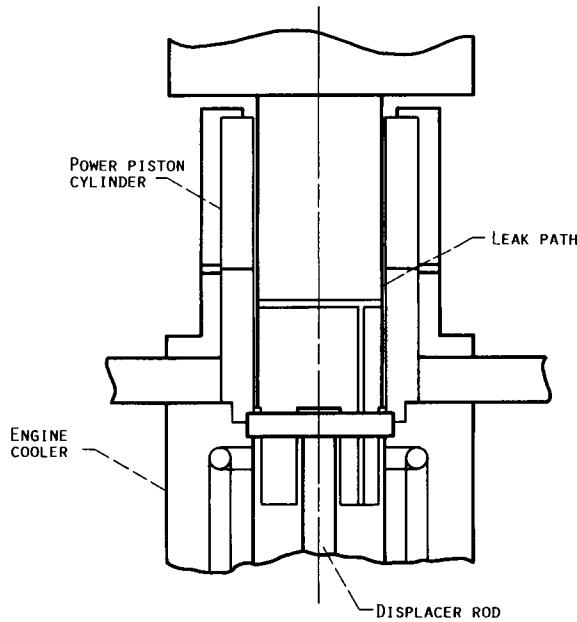


FIGURE 18.- RE-1000 ENGINE CENTERING PORT PRESSURE DROP FOR DISPLACER GAS SPRING AND COMPRESSION SPACE.

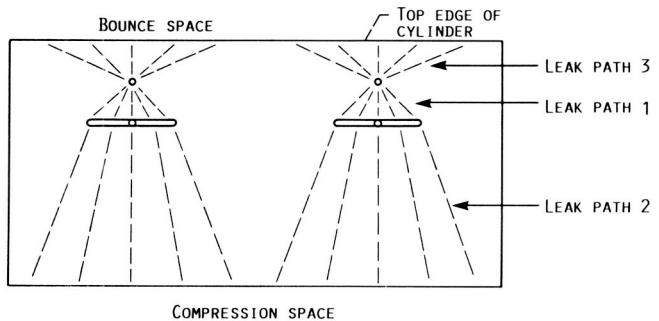


(A) WHEN POWER PISTON IS ABOVE CENTER PORTS.

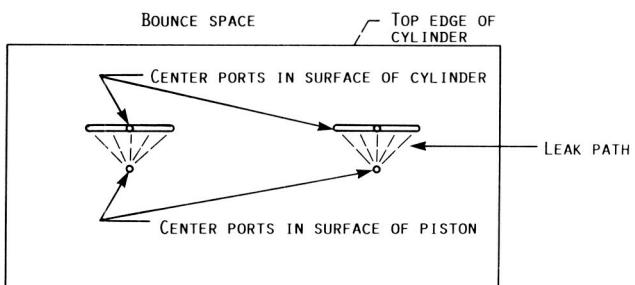


(B) WHEN POWER PISTON IS BELOW CENTER PORTS.

FIGURE 19.- SCHEMATIC OF LEAK PATHS PAST POWER PISTON.



(A) WHEN POWER PISTON IS ABOVE CENTER PORTS.



(B) WHEN POWER PISTON IS BELOW CENTER PORTS.

FIGURE 20. - GEOMETRY OF LEAK PATHS PAST POWER PISTON. THE CENTER PORT IN THE POWER PISTON CYLINDER IS A 1.1-MM-DIAMETER HOLE WITHIN A GROOVE 30 MM LONG, 1.25 MM WIDE, AND 0.75 MM DEEP.

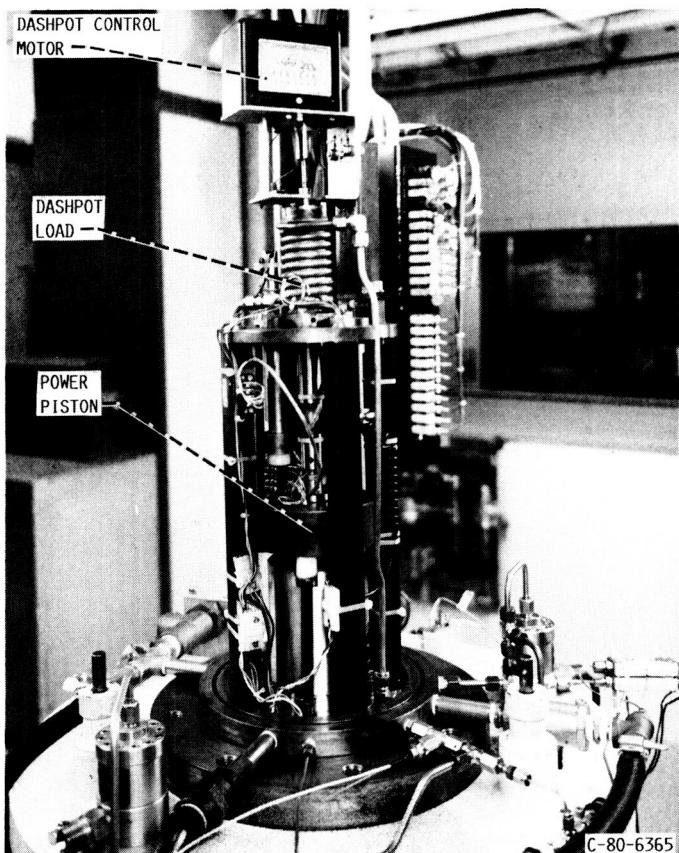


FIGURE 21. - RE-1000 IN TEST CELL WITH PRESSURE VESSEL REMOVED.

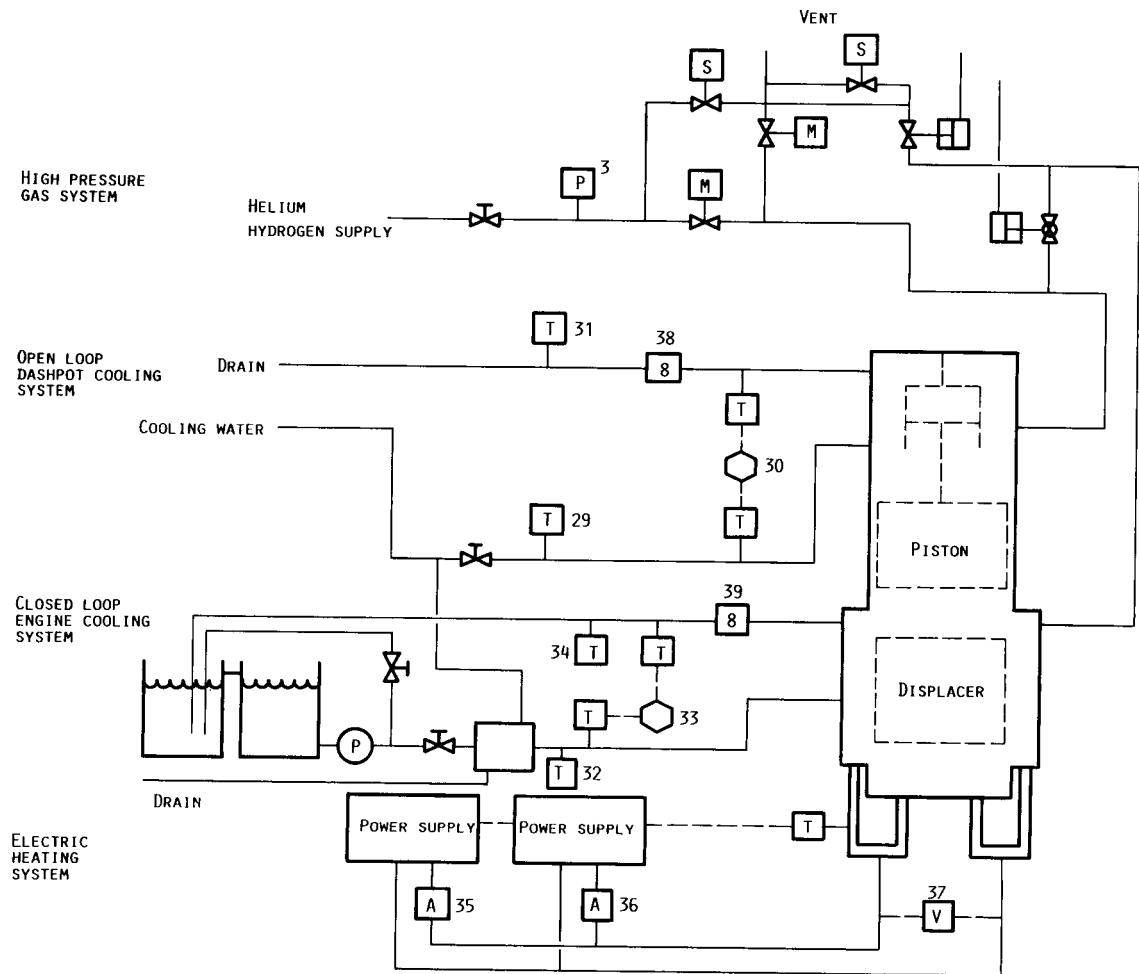


FIGURE 22.- RE-1000 TEST SCHEMATIC.



FIGURE 23. - CONTROL ROOM.

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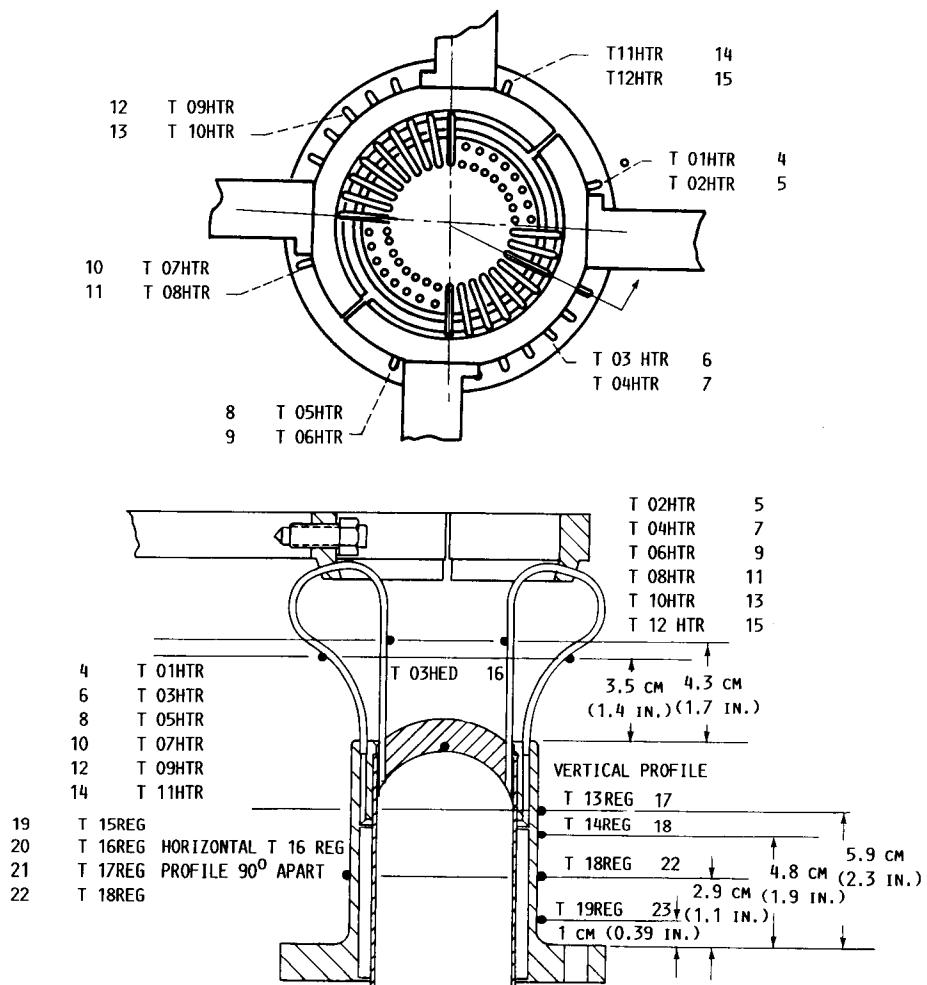


FIGURE 24.- RE-1000 HEATER HEAD THERMOCOUPLE LOCATIONS.

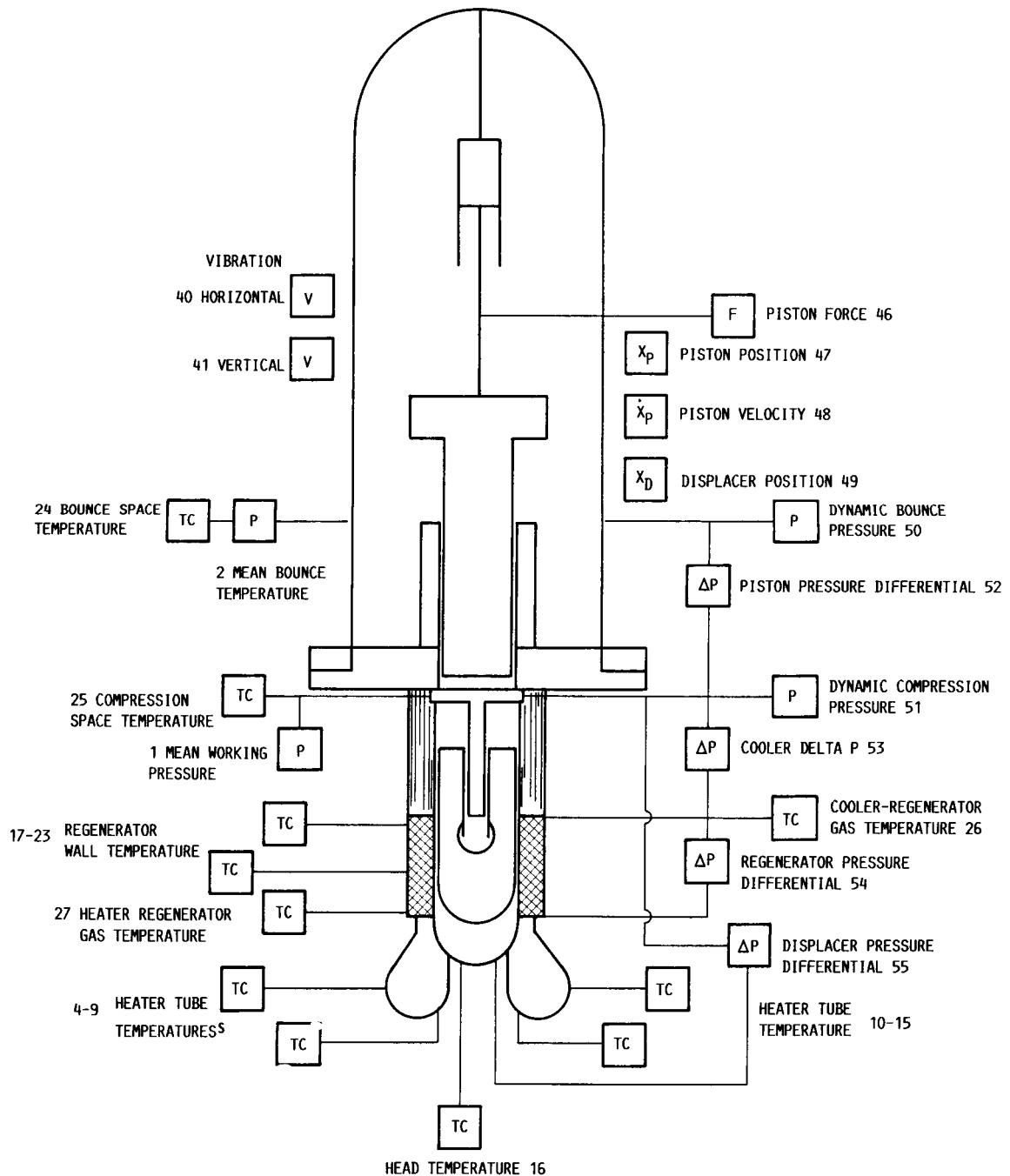


FIGURE 25.- INSTRUMENTATION LAYOUT OF RE-1000.

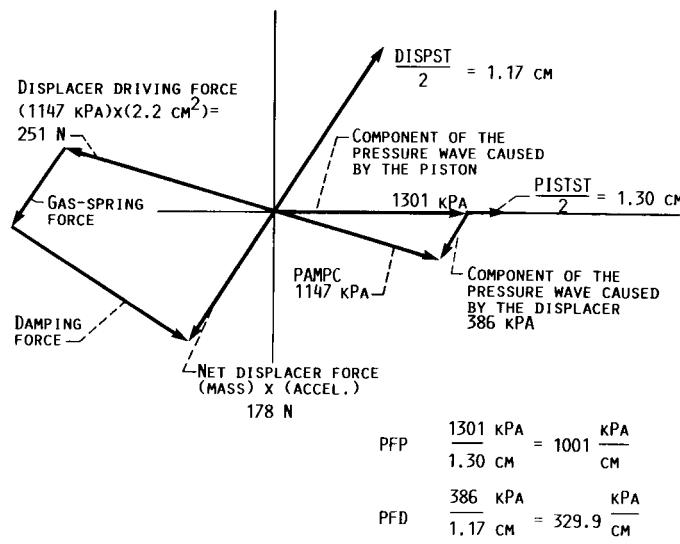


FIGURE 26.- PHASOR DIAGRAM OF THE RE-1000 AT DATA POINT 1010, DESIGN CONDITION.

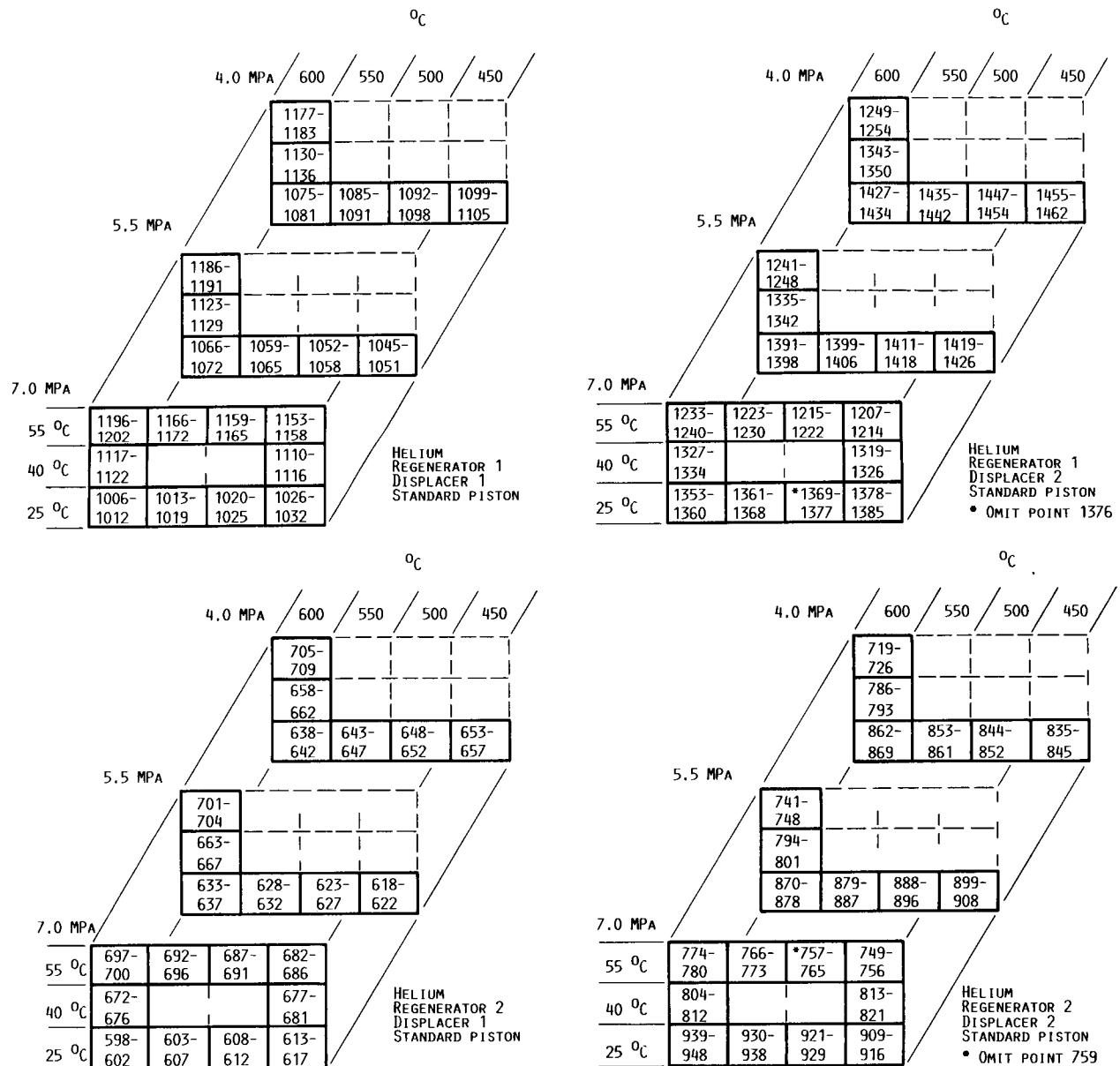


FIGURE 27.- TEST MATRIX WITH READING NUMBERS.

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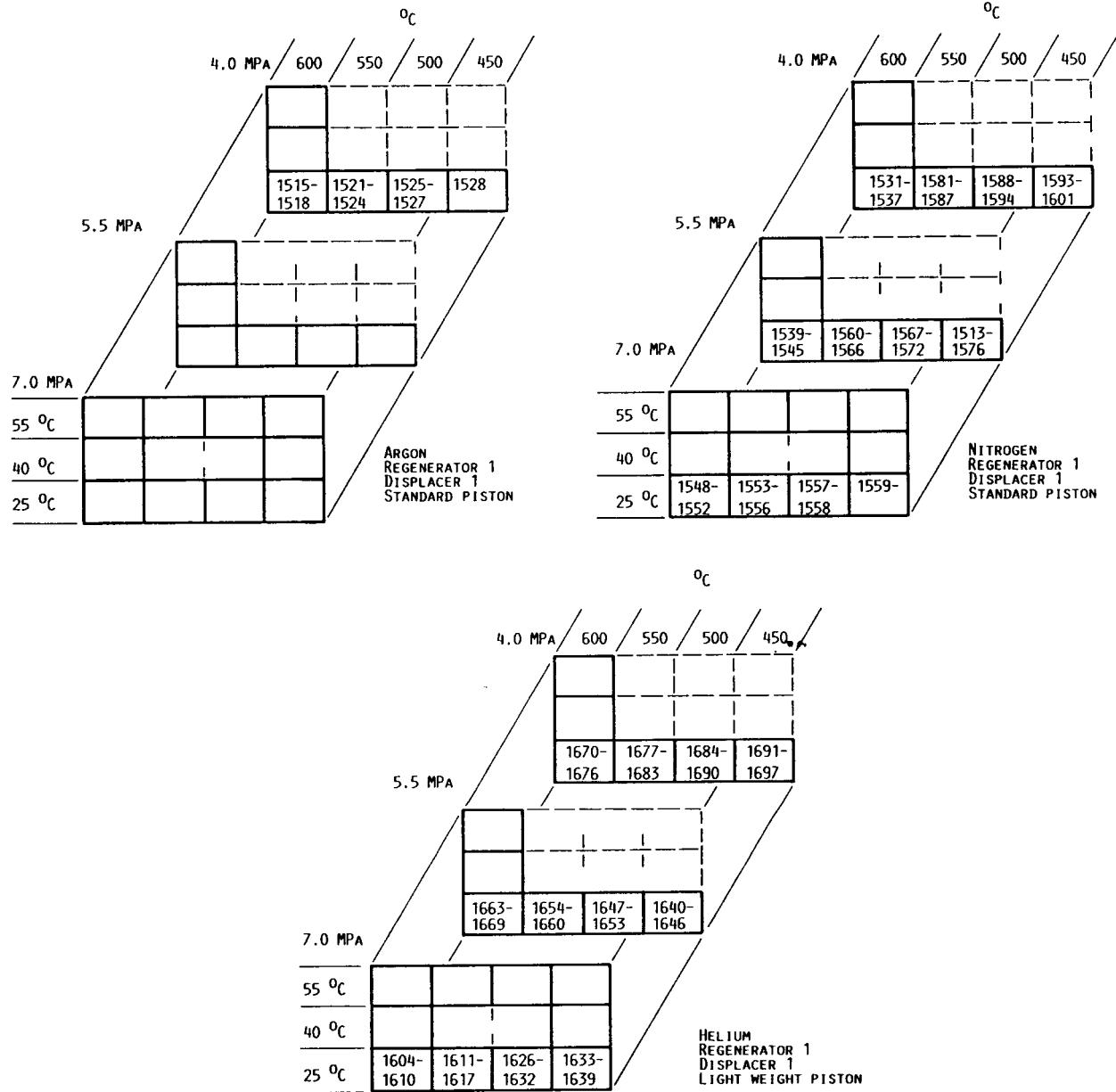


FIGURE 27.- CONCLUDED.

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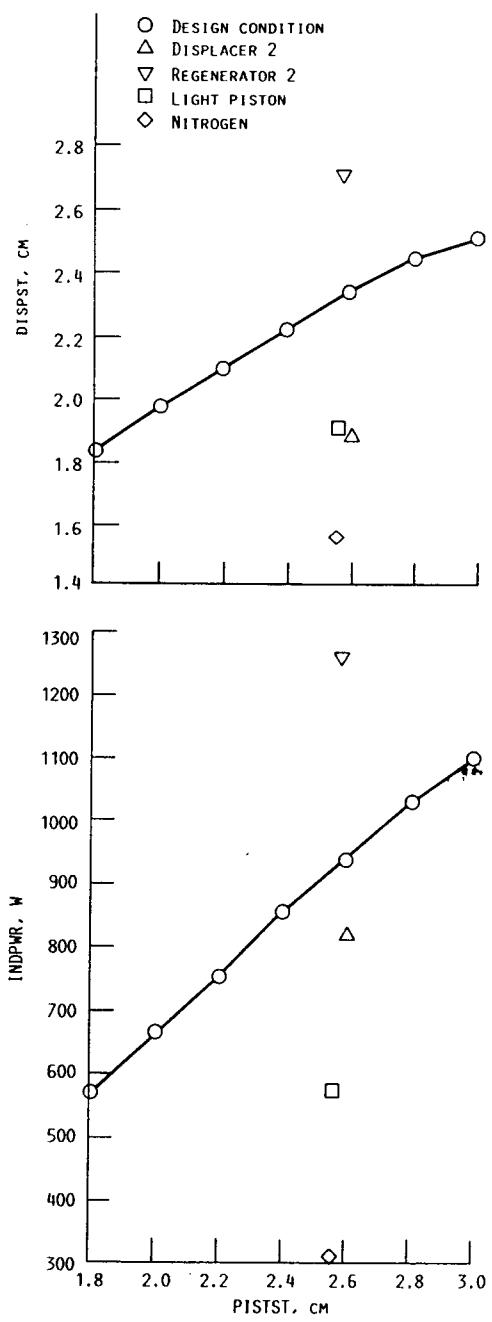


FIGURE 28.- DATA PLOTTED FROM THE SINGLE VARIABLE DATA SET (SVDS).

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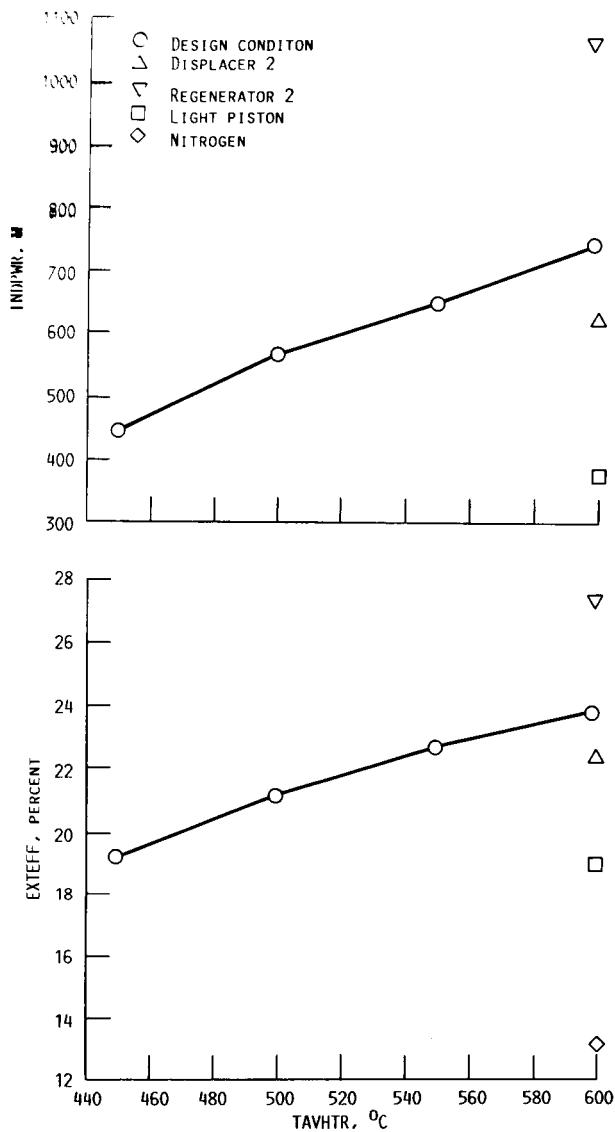


FIGURE 28.- CONCLUDED.

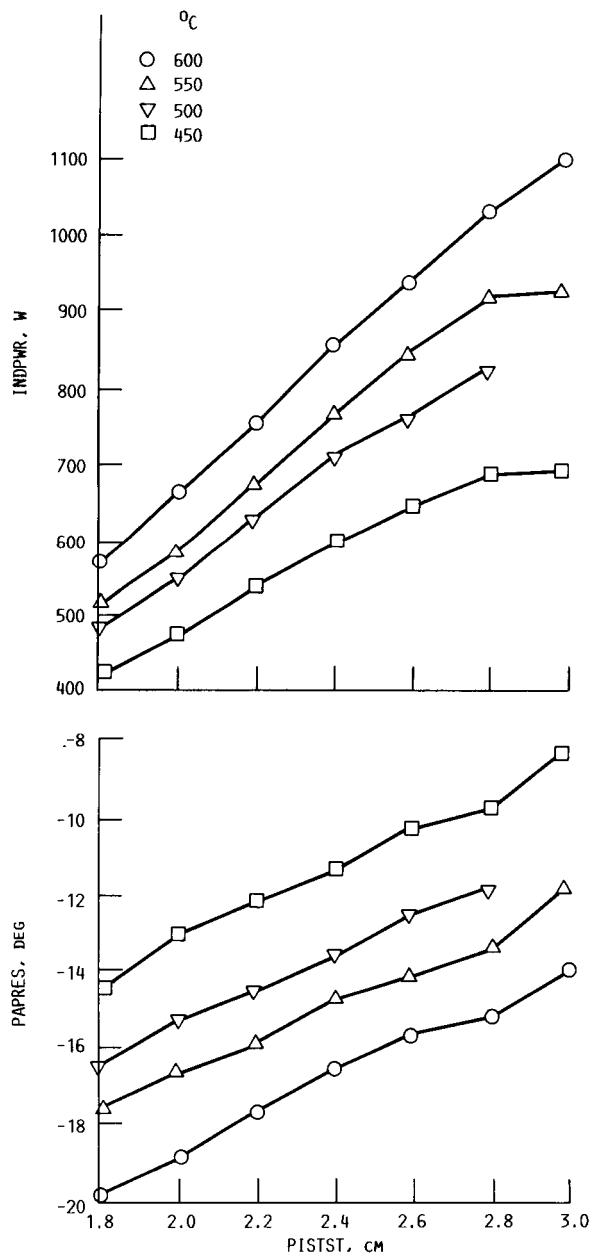


FIGURE 29.- DATA PLOTTED FROM THE DOUBLE VARIABLE DATA SET (DVDS).

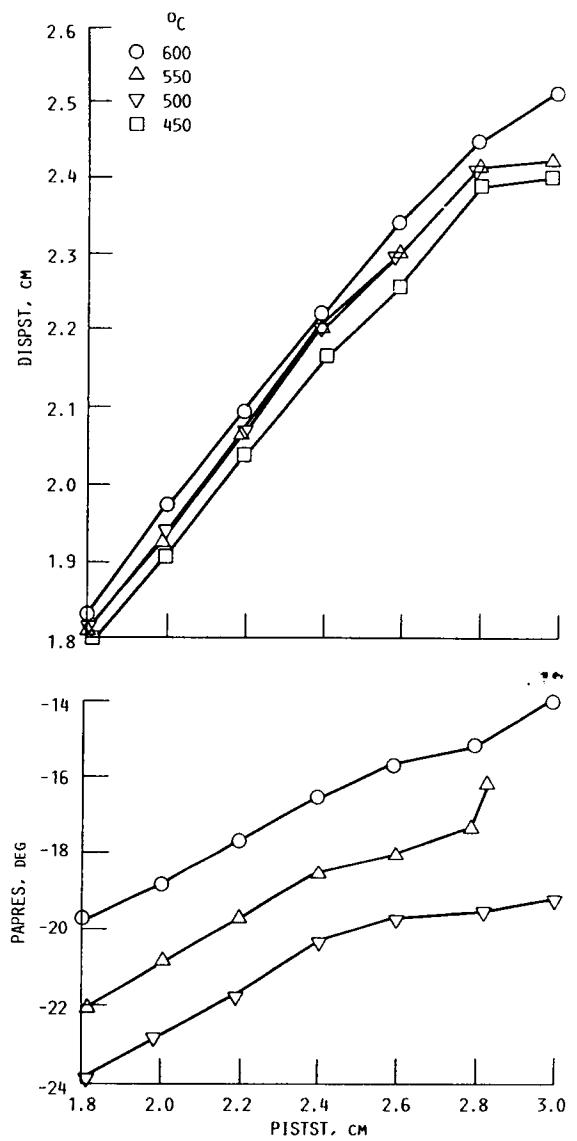


FIGURE 29.- CONCLUDED.

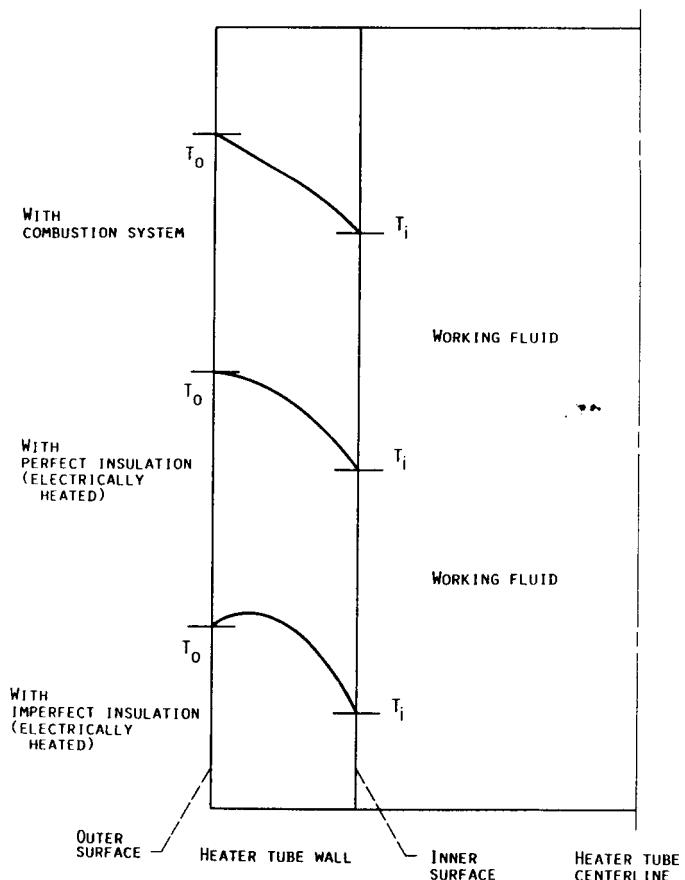


FIGURE 30.- HEATER TUBE TEMPERATURE PROFILES.

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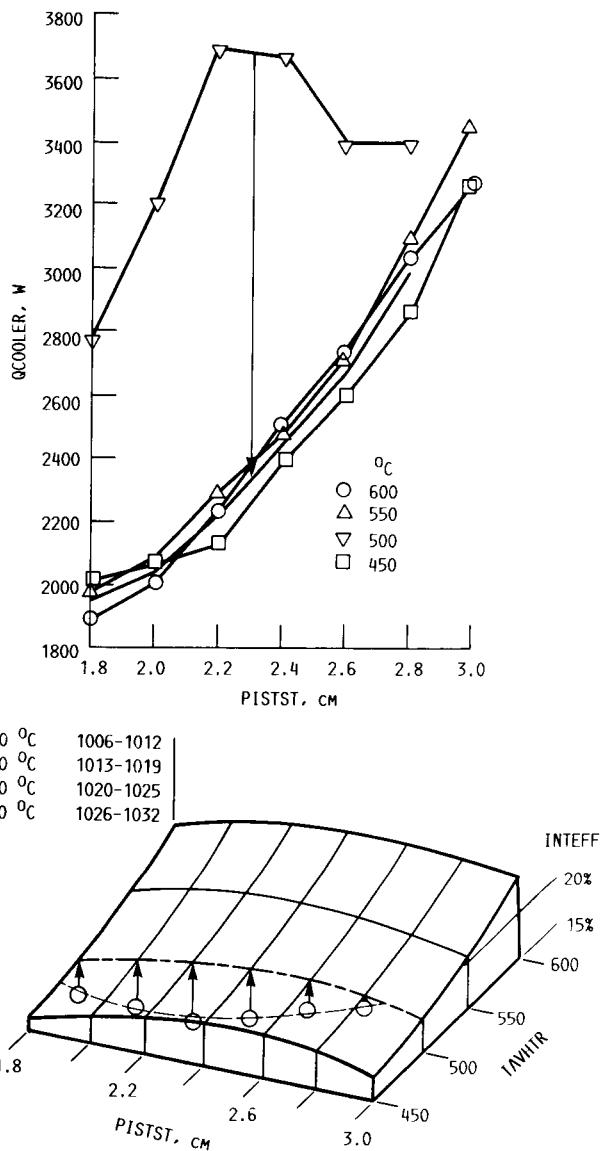


FIGURE 31.- CORRECTION OF FAULTY QCOOLER READING FOR DATA POINTS 1020-1025.

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16. Abstract <p>The NASA Lewis Research Center has been testing a 1 kW (1.33 hp) free-piston Stirling engine at the NASA Lewis test facilities. The tests performed over the past several years have been on a single cylinder machine known as the RE-1000. The data recorded were to aid in the investigation of the dynamics and thermodynamics of the free-piston Stirling engine. The data are intended to be used primarily for computer code validation. NASA reports TM-82999, TM-83407, and TM-87126 give initial results of the engine tests. The tests were designed to investigate the sensitivity of the engine performance to variations on the mean pressure of the working space, the working fluid used, heater and cooler temperatures, regenerator porosity, power piston mass and displacer dynamics. These tests have now been completed at NASA Lewis. This report presents some of the detailed data collected in the sensitivity tests. In all, 781 data points were recorded. A complete description of the engine and test facility is given. Many of the data can be found in tabular form, while a microfiche containing all of the data points can be requested from the NASA Lewis.</p>			
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